Report

Guidelines for the preparatory work needed to implement a TORC training program

TORC Project Deliverable D1.2 and D1.3

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Training for Operational Resilience Capabilities
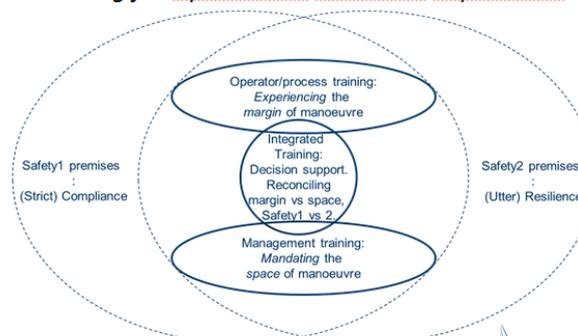
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ABSTRACT

Training for Operational Resilience Capabilities (TORC)

The TORC project is a collaboration between SINTEF, TNO (Netherlands) and Dédale (France) as a result of the first joint SAF€RA ERA-NET call (http://call.safera.eu/2013/).
TORC training addresses the need to develop resilient capabilities to complement safety regimes founded on compliance to rules, based on a mandated space of manoeuvre.
This report provides guidelines for the preparatory work needed to implement a TORC training program, including a description of the TORC Board Game developed specifically for TORC training.

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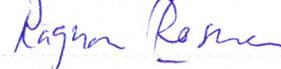
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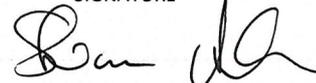
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SUMMARY

The TORC training approach enables organizations to appreciate, nurture and improve their inherent resilient and adaptive capacities, while being under the imperative of predominantly compliance-oriented safety regulations and standards.

TORC addresses three distinct yet coherent training arenas: *operational training* addresses the exploration of the necessary margin of maneuver in the "compliance vs resilience" space, *managerial training* addresses the assessment of a reasonable, accountable and legitimate space of maneuver, while *integrated training* addresses the active reconciliation of margin and space. This facilitates a continual process of updating of rules based on the enhanced knowledge about the professional competence in the organization at hand.

The TORC approach is applicable in different contexts; in a normal operation context where pre-existing rules and procedures form the expectations of compliance, in an emergency context in which emergency plans form the presumptions of compliance, and in a "managing the unexpected" context in which the applicable set of rules and procedures must be collected and formed instantly and situation-dependently.

The TORC approach is designed to support a structured process of putting resilience on a company agenda. A TORC *Training Structure* is recommended to be anchored in a strategic resilience objective and/or TORC-specific training objectives, from which Training Targets and Elements are successively built and supported by different Training Formats. However, amplified by the explicit appreciation of the compliance imperative, this may appear to be a very top-down approach to resilience, contradictory to the inherent "bottom-up" orientation of the resilience concept per se. It is therefore paramount to recognize that the main motivation for describing the TORC Training Structure is to provide a joint frame of reference that can also be used as a resource for inspiration, reuse and collaboration across organizations and industries. The intention is that TORC-based training can be used to support a wide variety of leverages and strategies to develop resilience; from sheer recognition and appreciation of existing (in-house) adaptive abilities and practices that can be conceived as rudimentary forms of resilience, via experimentation in order to develop the full potentials of those rudiments, to (TORC) *Capabilities* that integrate resilience in formal service delivery processes.

An initial step of sensitization is needed to gain advantage from TORC training and development. Therefore, actions and processes to support recognition and understanding of the potential for improved resilience, as well as contracting and project set-up is addressed in this report. The further intake and familiarization process lay the ground for effective and efficient TORC training. A number of key issues and working methods to support the familiarization process are addressed: selection of people to be involved; explorative interviews and (mini) workshop; document scan/review; selection of use cases, scenarios and possible capabilities; interviews with key employees; in-depth workshops; identifying target group and start-up communication on a TORC project; tentative training plan. Support for TORC Training development is also provided: operationalization of scope of training; sources and inspirations of resilient functionality; using the Capability concept; exploring and prototyping tentative interactive patterns; identifying enablers that should be included in the Training Strategy; developing a detailed Training Strategy; be sensitive to learning styles.

Although TORC training can be conducted through a variety of formats, the TORC project has chosen *gaming* as the key foundation for innovative training, aiming for the objectives and targets described above. The *TORC board game* has been developed as a key Training Format and sensitization device that supports and fuels operational, managerial and integrated training activities in terms of revelation of existing adaptive practices, exploration of hypothetical situations with close as well as more distant proximity to known practice, and joint reflections and after-action reviews, comprising both homogeneous and heterogeneous training groups. In effect, the TORC gaming format inherently supports a number of key Training Targets and Elements that encapsulate key features of TORC training for "resilience in context of compliance".

ABBREVIATIONS

AAR	After action review
CSF	Contributing Success Factor
CvR	Compliance versus Resilience
REL	Response-Execution-Leverage
SOP	Standard Operating Procedure
TT	Training Target
TE	Training Element
TF	Training Format
TS	Training Strategy

1 INTRODUCTION

Industrial organizations typically have strict compliance-oriented ("Safety-I")[1] safety management priorities. However, without the presence of a complementary adaptive capability, they are at risk of 'trapping safety into rules' (Bieder and Bourrier, 2013), implying a potential stagnation of safety performance. The intention of the TORC project is to provide a vehicle for sensitizing and developing a complementary "Safety-II" contribution in terms of *resilient capabilities - in the context of the compliance imperative* (Grøtan, 2015). The aim is to improve the adaptability and reliability of existing safety management in these organizations, under uncertain and shifting circumstances in everyday as well as crisis situations.

This report is founded on the previous TORC deliverable D1.1 '1st Concept Elaboration' (Grøtan et al., 2015) which serves as the theoretical foundation for the training approach. The overall aim of this report is to provide guidance for an organizational development process with the purpose of using and taking advantage from the TORC approach and method.

The key aim in an organizational development process based on TORC training is a practical consolidation of the *resilience in context of compliance* approach*,* customized to the organization at hand, but based on a generic model. The guidance in this report has evolved in interaction with practitioners from several industry partners across Europe. As indicated in Figure 1, the overall intention is to facilitate the development of resilience capabilities through three distinct but mutually supportive and coherent domains of training:

a) Operator/process training: operational teams maneuvering across and beyond "Safety-I[2]" system compliance boundaries
b) Management training: management providing the legitimate space of maneuver, i.e. putting conditions in place to facilitate maneuvering across Safety I system compliance boundaries and into "Safety-II[3]" in a transparent and legitimate way
c) Integrated training: management facilitating transactional (short term) decision support and (long term) conditions required for harmonizing the overall mutual shaping of the space between Safety-I and Safety-II in the operation.

TORC training will guide the participants in gathering experience with the present organizational boundaries, and to jointly explore and demarcate a functional and legitimate space of maneuver for resilient action. In addition, skills in further exploration of the potential of resilient strategies are generated.

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[1] See Hollnagel, E. (2014) Safety-I and Safety-II, The Past and Future of Safety Management, Ashgate
[2] Denoted "Safety-1" in Figure 1
[3] Denoted "Safety-2" in Figure 1
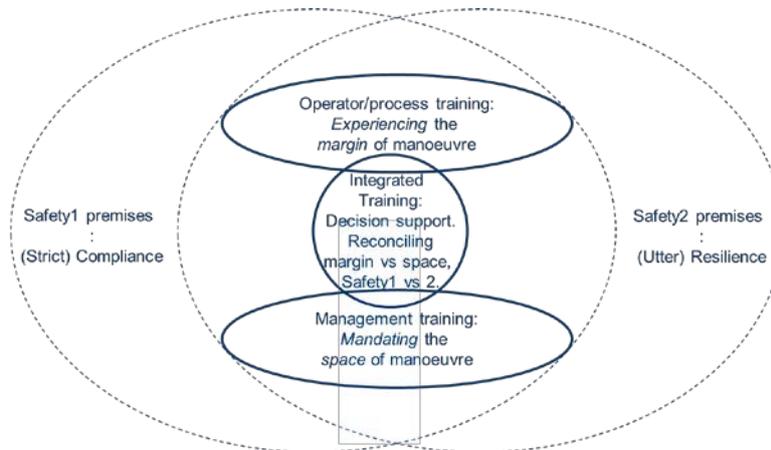
Figure 1. Distinct TORC training objectives

1.1 Key premises for TORC training

The objectives of operational, managerial and integrated training are distinctive and diverse, but mutually coherent in relation to the TORC rationale described in D1.1. The distinctions between these types of training, as well as the overall "resilience in context of compliance" premise, must be clearly communicated to and appreciated by the company's management.

Resilience requires organizational, managerial and operational sensitivity to and deep understanding of patterns in operation and performance (Lay, Branlat & Woods, 2015). As TORC training effectively and deliberately will address and engage existing resilient "rudiments" that can developed into a legitimate resilient capability, the TORC approach also implies an urge for "thick"[4] descriptions of situations and practices. That is, urging not only for "facts" but also of commentary, interpretation *and* interpretations of those comments and interpretations. Hence, "frozen" snapshots at specific times and occasions, providing only factual accounts without any desire for interpretation, is not sufficient to gain full advantage from the TORC approach.

TORC draws attention to operational boundaries. It is important not to draw the operational boundaries too narrow from the outset, but instead allow dynamic and flexible boundaries. TORC training presumes a managerial stance of asking "what do you need", rather than running blame games around slips and errors. "Error" must be acknowledged as a window to the health of the system, rather than being addressed as a subject for elimination. Narratives and stories of near-misses as well as successes must be regarded as key learning assets. These will not be available without a substantial degree of trust and confidence at the "sharp" end of the organization, requiring, e.g., the absence of "blame-games" when tacit and unconventional practices are addressed. Hence, buy-in must be sought and gained not only from the top, but from field staff as well.

A prerequisite for successful TORC training is thus that management promotes a climate of confidence and trust and maintains this as an inherent part of the training. This is necessary in order to enable an open dialogue on experiences, beyond "right vs wrong" from a compliance perspective, enabling elicitation of

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[4] See http://culturalstudiesnow.blogspot.no/2012/05/clifford-geertzs-thick-description.html (downloaded 2016-07-04) for an explanation of the (ethnographical) origin of the term

current practices and recognition of windows of opportunity to explore and highlight what may be needed to bridge the gap between work as imagined and work as done.

TORC training aims for a gradual appreciation, consolidation and development of resilience capabilities. This will inevitably challenge the position of procedures, but TORC training will constantly aim for a coherent combination and reconciliation (between compliance and resilience). In that respect, TORC is designed to be effective at nurturing and leveraging *improvement* rather than re-design of procedures, enabling a lasting and *mutually shaping* relationship between the formalized[5] view of the system and the rudiments and aspirations of resilience in the organization. This is done in a manner which also appreciates and supports the intentions behind the compliance foundation, which are partly expected and imposed from the outside of the organizational boundaries.

TORC also effectively aims for resilience in a way that can be extended beyond the domain of safety in a strict sense, e.g., accommodating optimization of operations. Resilience is thus regarded as a concept useful for both overall management and the safety department. As a concept, resilience may aid an organization to be more effective in terms of operation, while at the same time sensitizing it to danger and risk.

1.2   The TORC Training Structure; a joint frame of reference

The overall aim of this report is to provide guidance for an organizational development process with the purpose of using and taking advantage from the TORC approach and method. The point of departure for such an endeavor may vary substantially. In addition to the mandatory sensitivity to each organization's unique history of operational constraints, the guidance presented in this report seek to address the following concerns;

1. TORC training should not commence from a contextual void, a certain degree of preparation and priming of the organization to the TORC specifics is always needed.
2. For some organizations, it might be important to ensure that resilience training is guided by clear objectives that can be integrated at a policy level. In other words, they might demand an explicit *strategic objective* for their efforts related to resilience
3. Some organizations might be interested in sharing or reusing smaller or larger parts of other organizations' training activities, without requiring a strategic resilience objective.
4. Other organizations might have a more open approach and will just want to see how TORC training works and evolves, but might still need a leverage or inspiration in order to get started

Hence, generic guidance for contracting, project set-up and intake as well as training content development is needed in almost any circumstance. This is described in the next chapters. However, related to the concerns labeled 2-4 above, the TORC *Training Structure* (Figure 3) is meant to serve as a joint frame of reference, facilitating sharing and reuse of assets related to TORC training.

In the TORC Training Structure, the notion of *Training Targets* (TT) is a key reference. Depending on the actual need and point of departure of organization in question, the TTs may have different origins. Figure 2 illustrates that TTs[6] *may* on one side be derived from the strategic resilience objective of the organization. The strategic resilience objective denotes a statement of what the organization wants to achieve by means of the resilience concept (and thus for TORC training), at a policy level, e.g.,

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[5] Sometimes more provocatively denoted "the rational facade", e.g., by Grøtan (2015)
[6] Examples are given in chapter 2

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- How and to what extent the organizational efforts of achieving resilience should be contrasted with the "Safety-I" safety management scheme in terms of the *complementary*, *dialectical* or *shaping* relations[7]
- To which extent resilience is relevant for application towards normal operation, emergency situations, managing the unexpected, or others
- To which extent the whole range of TORC training (operational, managerial, integrated) is applicable and employed, or if just a subset shall be used
- The degree to which resilient experiences should be used to update or challenge the compliance base[8]
- The maximum aspiration levels[9] for resilience in different application areas and contexts
- The transition points[10] between different application areas (normal, emergency, unexpected)
- A strategy for a gradual[11] build-up of resilient capabilities[12]

On the other side, Figure 2 also indicates that the Training Targets could[13] be based solely on the unique TORC distinctions between objectives of operational, managerial and integrated training.
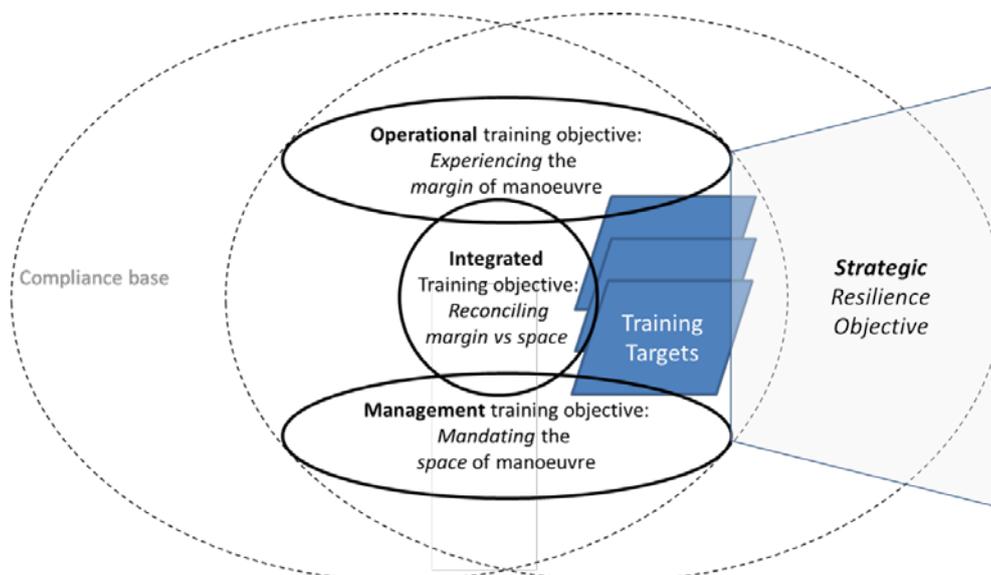
Figure 2. TORC Training Targets derived from objectives

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[7] See D1.1 and Grøtan (2015)

[8] A minimum level could be that TORC training is used merely to explore and create awareness of when procedures are violated. A maximum level could be an aspiration to minimize the number of rules and make them as generic as possible

[9] E.g., the organization may decide that one part of the operation can be allowed to train for "stretch" (R3), while others must restrict themselves for "defend" (R1) (for explanation of R1-R4, see Table 1. Summary of modes of resilience, p22)

[10] E.g., the organization may decide that the TORC training of normal and emergency operation should be connected in the sense that any sign of an "R3" condition automatically implies an emergency situation, both of which covered by TORC training

[11] E.g., that parts of the organization shall build (R1-R4) capabilities accumulatively, while other are allowed to train for "R3" capabilities directly

[12] The capability concept is described in chapter 1.4

[13] That is, in order to be labeled a TORC training target

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Ideally, the Training Targets should be a set of the latter, conditioned and flavored by the former (i.e., the strategic objective). However, in line with the pragmatic concerns listed as "2-4" above, it is also possible to adopt the TORC (operational, managerial, integrated) objectives and targets in a more straightforward manner, without an elaborate strategic resilience objective behind.

As described in D1.1 and illustrated in Figure 3, the TORC Training Structure comprises the notions of Training Targets (TT), Training Elements (TE) and Training Formats (TF) as a basis for Training Strategies (TS).
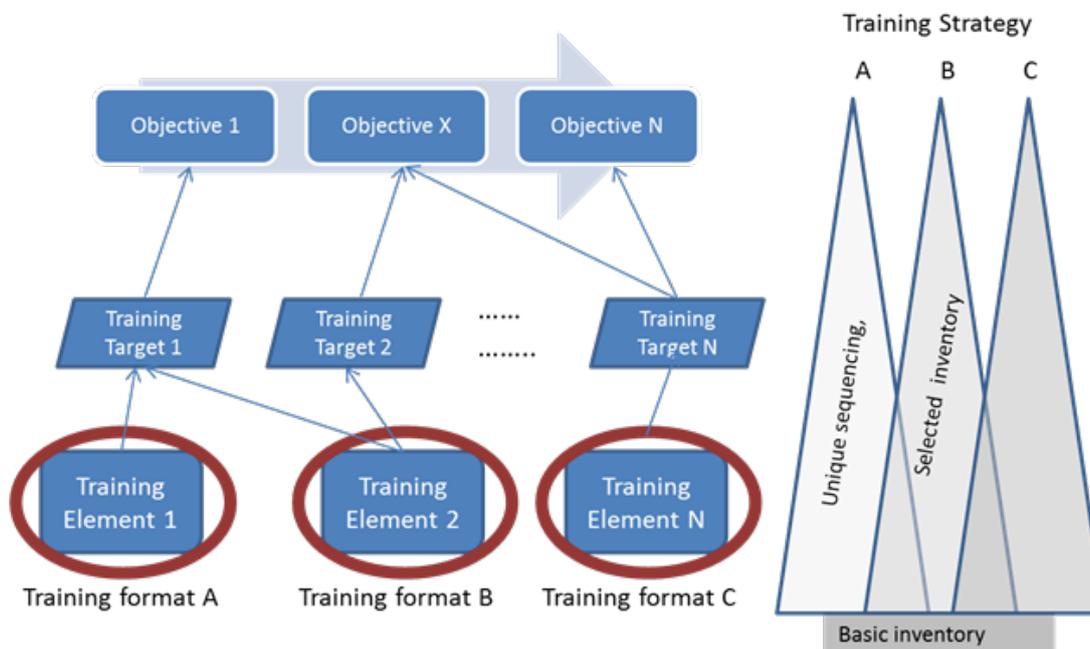
Figure 3. TORC Training Structure

The essential distinctions between the constituents and results in terms of a Training Structure must be clearly communicated to the company's management:

- The (generic) Training Targets (TT) operationalizes the TORC-specific rationale, objectives and sub-objectives at a system level (as described in D1.1) in terms of *goals and effects that can be addressed through training*. A list of TTs is proposed in Table 2, p23
- A Training Element (TE) is a distinct training activity, aiming at implementing the intentions of one or more TTs. Both initial conditions, basic activities and possible outcomes are recognizable at the "home ground" of the trainees, who also will be challenged and exposed to surprise and unusual variations. A typical example is to start with *a seemingly normal operation and then expose them to various disturbances* that renders the SOPs and routines more or less incomplete or even useless. By calibrating a sequence of disturbances, only a few or several TTs (see Table 2) might be employed
- A Training Format (TF) is a specific way of conducting a TE (e.g. by off-line class-room training, training on the job, gaming, etc.). Here, it is important to keep in mind that the various formats differ in their inherent capacity to amplify and support the different TTs, (almost) irrespective of the actual

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TE. For example, *a gaming format provides comparatively more opportunity* to enforce "Training Target B: Ensure sensitivity to decisive moments" (see Table 2) by virtue of the game design[14].

- A Training Strategy (TS) is a set of TEs (and TFs) arranged and delivered for the purpose of a specific[15] organization, serving its needs and unique prerequisites. A TS corresponds to a training package composed and designed to support a specific business context.

In case the TORC training structure does not fit the standards and vocabulary of the client, this must be adapted and/or translated. In addition the Training Strategy will need specific adaptation to company needs, training programs, and other preparations in order to make the organization receptive for employing the (TORC-specific) resilience concept. E.g., for a specific group of people operating in railroad maintenance, specific resilient capabilities may need to be trained given their specific organizational and compliance context.

The TORC Training Structure is not meant as a rigid straitjacket but as a supportive structure to maintain the basic premises for "resilience in context of compliance", while at the same time being open for taking on board useful theoretical inspirations from, e.g., the Resilience Engineering or generic safety training literature. The overall idea is that:

a. The unique TORC premises ("resilience in context of compliance") are maintained by using the TORC objectives and TTs as building blocks for articulating the strategic resilience objective of the organization

b. Additional perspectives, inspirations etc. can be taken onboard as part of the operationalization of the scope of training and the selection/development of Training Elements (TEs) (see also Grøtan et al., 2016)

c. Anyway, each organization will have to define its own Training Strategy (TS); the unique strategic and operational scope (TTs), the unique selection and sequencing of TEs and choice of Training Formats (TFs).

First and foremost, this generic training structure facilitates the design of an organization-specific TS guided by clear objectives, e.g. as a series of sub-objectives derived from the context depicted in Figure 2. A Training Target (TT) can in principle serve one or more sub-objectives, and is also generic enough to be re-used across organizations. However, on the other side, one or more TEs can also be picked with the sheer motivation of sharing or reusing smaller or larger parts of other organizations' training activities, either as an implication of commensurable objectives and targets, or from the sheer need for a leverage or inspiration in order to just get started and gain experience.

This approach will be illustrated in more practical terms throughout this report.

1.3   Areas of application

It is the privilege of the strategic resilience objective of the particular organization to define the application area for TORC. However, the intended TORC application areas have been:

1. Training for increased resilience in *normal operations* (in which the "compliance context" is demarcated by the safety management system and defined procedures)

2. Training for increased resilience in *emergency preparedness* (in which, e.g., *Defined Situations of Hazard and Accident* (DSHA) together with the emergency plans form the "compliance context")

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[14] This is actually the case for the TORC board game, see chapter 4.4.
[15] Illustrated by labels "A", "B" or "C" in Figure 3. *TORC Training Structure*

3. Training for increased resilience in the approach of *unexpected/surprise situations* (in which the "compliance context" must be identified and coped with "on the spot", as part of the training)
4. Training for increased resilience in *combined scenarios* – escalation (e.g. on the interface between "normal" to "emergency" situations).

It is expected that Training Elements (TE) can be reused across these application areas. However, the *contextualizations* will be different. This is an issue that can be supported by the *TORC Capability Concept* (see below), providing an optional point of departure to compose Training Elements.

1.4 TORC Capability Concept

As indicated above, the use and reuse of TEs across different application contexts is an inherent challenge for a broad use of the TORC concept. In addition, also in the case of only a single application area, there is an inherent need to be able to trace and account for the effects and achievements of TORC-based training. For such reasons, the TORC *Capability Concept* is designed to support an organization to anchor the resilience gained into teams, across the organization and into a business and service delivery context.

The theory and literature offer multiple definitions for the term "capability". For TORC, a capability is understood from the outset as a specific combination of human and organizational aspects (competences, strategies and resources) which can be recognized as distinct enablers and vehicles of resilience.

The TORC working definition for capability is:

A resilience capability is the ability to perform or achieve certain actions or outcomes through a set of controllable and measurable faculties, features, functions, processes, or services and encompasses:
- *competences*
- *resources and*
- *a strategy to make competences/resources "meet" in an effective manner,*

Hence, capabilities enable organizations, to a certain extent, to "program" a repository of sustainable adaptive responses to demands due to e.g. disturbances, disruptions and change. A capability can be found at individual, team and organizational levels. In this context:

- *Competences* are clusters of knowledge, skills and attitudes which are necessary to perform tasks, solve problems, and more generally to execute a job, a function or a certain role.
- *Resources* are sources of knowledge, technological or organizational facilities and structures available or to be deployed to support resilient activities and business services.
- *Strategies* are inherent or prepared mental concepts to be applied to guide informal and formal decision making and direct the adaptation process. A strategy may be learned or improvised.

A capability can have several maturity levels that can be associated with a stepwise aspiration level to be developed for sustained resilience. The use of a resilient capability may inherently lead to shifts and progression of competence envelopes by learning and adaptations as a result of successful actions. E.g., after action reviews of successful resilience practices and experience may feed the resilience repository of the organizations by means of memorizing successful coping behavior. It may even generate input to the learning organization, leading to new training and procedures that make the organization better prepared for future challenges of a similar kind.

The generic capability model in Figure 4 illustrates the relationships between resources, competences, capabilities, the delivery process and the business level in an organization.

- *Service delivery process*: "activates" and controls service delivery (e.g. through procedures, responsibility assignment (RACI[16] matrix) and risk management). Depending on the variation in services an organization offers[17], it may have one or more variations of this process, e.g. a process for processing commodities (high degree of standardization) and a project management process (very limited standardization).
- *Service:* a single capability or a combination of capabilities adapted or harmonized to respond to the client requirement. It represents the mutual understanding or "contract" between service provider, client and operations and it forms the basis for evaluation or learning and for homogeneity if the service is repeated.
- *Capabilities*: "things an *organization* is capable of doing". A capability is the smallest part of a service that can be delivered; internally or externally. In its specification, it identifies the scope, the skills/tools required, the resources and competences required.
- A *resilience capability* thus adds adaptive power to a service delivery, but the connection to the service as such is a *strategy* of employing resources and competencies. The strategy may be prepared or improvised when coping with variance and disturbances. E.g., an emergency organization has a well prepared set of strategies and resources to be implemented dependent on the situation and emergency.
- *Resources*: individuals are the most important (human) resources. The individual is hierarchically positioned in an organization through line relationships. *An individual bears competences*: "things an individual is capable of doing". The hierarchical relationships are no longer relevant. Other resources may be company assets, know how, procedures etc.
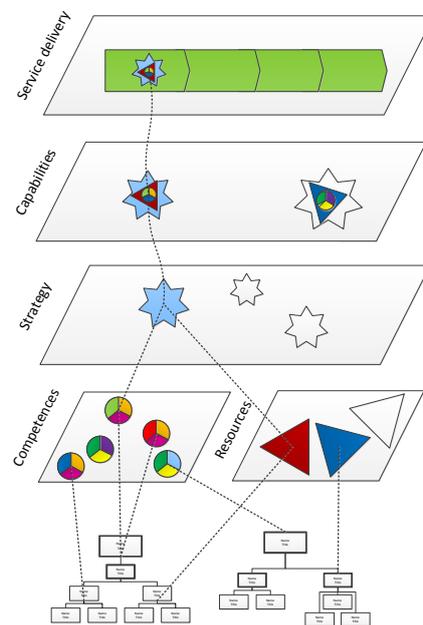
Figure 4. Overall TORC Capability Structure (adapted from D. Zuiderwijk)

In TORC, the upper level of Figure 4 (services, service delivery process) corresponds to the different application contexts (e.g., normal operation, emergency), including a more specific elaboration of the *"use*

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[16] Responsibilities, accountability, advisory and information lines
[17] E.g., as on the range of commodity versus unique services

cases" that will be the operational background for the training as source of experience, reference and recognition. This also implies that this level will have to be linked to the strategic resilience objectives in terms of (TORC) objectives and TTs (see chapter 1.1 herein and D1.1) as a source or reference in order to design a company (operational and training) strategy implying the anticipated need for resilience capabilities.

Hence, the upper level of Figure 4 corresponds to the "context[18]" element of the TORC Capability Structure introduced in D1.1 (as repeated in Figure 5 herein). The TE "demand" and "outcome" of the latter is a *prototypical[19]* (but not exhaustive) description of a resilience capability playing out at a service/use case level.

Figure 5. TORC D1.1 Capability Structure

The "adaptive inventory[20]" of Figure 5 corresponds to Resources and Competences/Skills in Figure 4, while the notion of "(S)REL[21] capacity" of Figure 5 corresponds to the *interactive pattern* (see also chapter 3.2.3 herein) inherent to the "Capability" level in Figure 4. Moreover, specific strategies, protocols, heuristics or leverages are needed in order for a single agent (individual or team) to *activate and execute* a capability: that is, to be able to mobilize the support and collaboration of other skilled/competent actors in a concerted manner in a given situation in which resilient action is needed or demanded. E.g. a railroad maintenance crew may need to involve the train traffic controller to cope with disturbances requiring adaptation of work plans.

Hence, the "proof of the pudding" regarding a resilience capability lies in the demonstration of the ability to invoke and apply a strategy to mobilize resources and competencies (the "inventory") in a joint interactive effort when the actual need is there. Practically speaking, TORC training may likely not be able to invoke the full-fledged capability per se, but it may be possible to maintain a link between the TE and a broader capability as a context, through "use cases". However, a substantial part of TORC training will also have to be on more fragmented parts of the "inventory"; individual/team- strategies, competences, skills and resources.

1.5   Scope of this report

This report provide a guideline for the preparatory work required to implement a TORC training program, the minimum requirements to the compliance foundation and the strategic framing of resilience, as well as the principles for identifying and nurturing existing adaptive capabilities. It also describes how sensitization is facilitated at an industry partner and how a TORC training program is accommodated, prepared and facilitated with an industry partner for use during piloting. The *TORC Training by Gaming* Format will be

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[18] The "TNO Matrix" here denotes a framework of resilience resources described in D1.1, but which is not important for this report.

[19] The emphasis on "prototypical" is important because, by implication of the very concept of "resilience", a resilience capability cannot, and should not, be a priori confined to a deterministic and overly "closed" functionality.

[20] CSF: Contributing Success Factors (Størseth et al., 2009)

[21] (S)REL: (Stratified) Response-Execution-Leverage (Grøtan, 2011)

described. The training elements available as a result of piloting activities will be described in a separate report.

Note that while the ultimate goal of the SAF€RA TORC project per se is to leave behind a set of guidelines and a training repertoire that can be applied by companies on a self-sustained basis, the present version of this guideline promotes the option for companies to engage external support in designing their own strategy. Such engagement can follow the development of a Training Strategy in a similar way as TORC Consortium partners have been cooperating with their industrial partners engaged in the SAF€RA TORC project. We believe this experience and the templates delivered will offer a faster track to achieving the intended results when developing a TORC training after this project.

1.6   Acknowledgements

The TORC project acknowledges the contribution and cooperation of:

- SAF€RA
- Founding partners: Norwegian Research Council (No) and FonCSI (Fr)
- Research partners: TNO (NL), SINTEF (No) and Dédale (Fr)
- Industry partners: Infraspeed Maintenance BV, NAM and Strukton Rail (Nl)

for supporting, developing and piloting the contents of the present version of this report.

2 Sensitization for TORC training and development

By implication of the introduction above, it is presumed that a company[22] must to some degree be sensitized to the specific TORC premises (see section 1.1) for a TORC training program to be successful. In any case, management commitment and a formal and contractual anchoring is necessary.

Sensitization is not possible without motivation. Motivation can be found in the experience of others in similar situations. But motivation can also be found at the organization's own doorstep. By just appreciating the past and present tacit adaptations vs actual procedures in own organization, the TORC rationale is presumably almost normalized. The need – and will – to put more emphasis on resilience is a matter of incremental strategy and pragmatic orientation, not the launch of a complete make-over. E.g., a company may become aware of several experiences of maintenance teams with situations that have developed in such a way that successful fulfillment of tasks required adapting and stretching rather than interpreting a procedure, and implementing unusual resources and strategies. If such situations are acknowledged to be recurring, it is no longer rational to let it continue behind a "rational facade". It may be time to look for more resilient strategies, to develop necessary capabilities and mandate adaptive responses in order to ensure that they do not get out of hand.

The experiences described in this report are based on the premise that the actual coupling between the researcher/trainer and the industrial partner is void of a previous history on the actual (resilience) matters. Hence, the developer of the TORC training needs to liaise with management and the safety experts to analyze the company's needs and history of adaptive practices, providing insight in past resilient behavior and even rudimentary, informal resilience capabilities. Both successful and unsuccessful[23] situations are useful sources for such an analysis.

As TNO's practical approach in the SAFERA TORC project is closest to this precondition, the recommendations given here are largely based on the TNO process in developing a Training Strategy, Training Elements and Training Formats with their Dutch industry partners. This experience finally led to the design of a serious game, the TORC game, as the key Training Format. The TORC game is described in chapter 4.

The main steps followed in the process of sensitization are:

1. Recognizing and understanding the potential for improved resilience
2. Contracting and project set up
   a. Defining the scope of the training strategy
   b. Consolidating and priming the compliance base
   c. Consolidating and priming the interactive repertoire
3. Intake process for the training development
4. Working method to support familiarization process:
   a. Selection of people supporting the project (company focus group)
   b. Explorative interviews and workshop
   c. Document scan/review
   d. Interviews with key employees
   e. Select use cases, resilience scenarios

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[22] The term "company" will be used to signify the organization engaging in TORC training. It will sometimes also be denoted industry partner, a trainee organization or client.
[23] Those that developed into damage

   f. In depth workshop(s) on location
5. Identifying target group and start-up of communication
6. Set up of tentative training development and implementation plan

2.1 Recognizing and understanding the potential for improved resilience

The sensitization process starts with understanding the potential for organizational learning and development from the concept of space of maneuver (see D1.1), and the associated ability to cope with unexpected demands. The process should encourage explication of "atypical" experiences of field staff when they (need to) experiment and use their - mandated or not - margin of maneuver out of necessity. The attention must then be directed to how to improve this in future. Field staff may be encouraged to optimize their operational mandate and receive necessary empowerment to cope with disturbances and changing situation in their work. Also complaints, dilemmas encountered and obstacles hindering the fulfillment of missions in an effective and safe way may need to be addressed.

This unfolding process of awareness and diagnosis may then initiate the exploration of the potential of resilience, herein the improvement of capabilities of people and teams to strengthen their responses to variations.

Furthermore, contacting and committing the right partners (customer, partners, company and training provider) is required to build the ground for a training development project[24].

The result of this step is:

- Understanding of the need and availability of practices for reconciliation of resilience and compliance
- An ambition to explore the potential of strengthening resilience capabilities
- Understanding of a possible course of actions to develop and implement the training
- Commitment for a partnership to improve resilience capabilities by training
- Identification of a training need

2.2 Contracting and project set-up

The success of a TORC project depends on a close cooperation in which the company is willing to participate in elaboration and development of a strategy and format for training where the – possibly challenging - interplay between compliance and resilient work capabilities will be elicited and explored. Elicitation of dilemmas and reconciliations between resilience and compliance need to be acknowledged as part of the training and its follow-up and may incite a dialogue on compliance policy and (re)interpretation of company values. Steps must be taken to ensure that the course of the TORC project is not halted, e.g., due to intimidation effects when established safety demarcations are challenged. Hence, the project must have a wide mandate in terms of issues addressed.

Establishing a partnership of a company with a competent (research/training) partner was crucial for the success of the SAF€RA TORC project forming the background for this report. This applies not only with respect to validating the concept from a scientific point of view, but also to enhance commitment to and participation in the search for improvements of resilience in operations.

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[24] The TORC project industry partnership has been established on this assumption and company awareness of the potential of strengthened resilience.

The starting point and basis for cooperation is a mental and business contract[25] between partners. This will open up a constructive and transparent relationship and dialogue between partners involved. This allows all partners to acquire e.g. confidential insights into the events (of use cases) that require both resilience and compliance practices in the company domain. However, this requires a sensitivity for balancing the need for acquiring insights (documentation, stories etc.) in actual company operations and experiences to be used in the training, vs business confidentiality. Mutual confidence in this respect will also set the stage for joint development of relevant Training Elements and selection of Formats, and for discussion and preparation for applying the effective instruments and appropriate guidance during implementation of the training. A good relation with the training and human resource management staff will facilitate the training development and engage additional knowledge and experience. Even more important, this will provide a good foundation to anchor TORC training in long term training programs and overall safety management.

As part of this phase, use cases of the company will be collected and studied to obtain insight in past and present adaptive behaviors in the operations of the client. Also the training methods (Elements and Format) will be explored. For this purpose, the company will have to identify the target groups for the TORC training and anticipate necessary facilities for the (pilot) training sessions.

2.2.1 Defining the Training Strategy and need for resilience for the company

The TORC approach invites the company to develop a playing field for "resilience in context of compliance", comprising modes of resilience or levels from R1 to R4 (see D1.1, page 33 and summary in Table 1 herein). It also invites the collection of use cases with different examples of past resilience experience in operations, e.g., normal operation and emergency operation (the use cases). Ultimately, it also invites to structure the Training Elements, achievements and activity accounts according to the Capability structure devised in chapter 1.4.

Table 1. Summary of modes of resilience

Mode of resilience	
Defend (R1):	This is close to the nominal mode of operation. Resilient action takes place to deal with everyday operational surprise within the boundaries of the normal operation.
Build (R2):	The organization is able to provide, en route, additional defenses by means of robustness added to the normal operational model at spots where there are known vulnerabilities or procedures need to be interpreted.
Stretch (R3):	On a case-by-case basis, controlled acting outside of the operational model is an option, when responding to unexpected situations for which the available work permits, procedures and resources no longer support necessary action.
Sustain (R4):	A state in which the organization continually accommodates resilient action within and between organizations as an operational capability, governed by a controlled resilience process which allows for proposing compensating measures immediately across the modes.

In practice, the full TORC space of potential resilience capabilities will not necessarily need to be applied for a single company/client. Hence, the scope of TORC training must be aligned with the strategic resilience objective at a policy level, and must be defined in terms of:

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[25] The Consortium Agreement for the Project SAF€RA Training Operational Resilience Capabilities served as contractual basis for cooperating all TORC partners. In addition, a more detailed cooperation agreement is signed which captures the industry partner's commitment to the TORC consortium. This partnership agreement governs arrangements such as work appointments, sharing knowledge and insights in the design of and participation in TORC instruments (formalized by a seat in the TORC Industry Focus Group).

- *Application contexts*: normal operation relating to procedures, emergency training based on emergency plans, training for unexpected situations and open contexts, or combinations thereof
- *Applicability*: of operational, managerial and integrated training for each context
- *Calibration*[26] of *aspirations* of resilience (R1-R4)[27] for each context, and transition points
- *Ambition level* for resilience-driven revision and renewal of rules and procedures ("CvR reconciliations")
- *Ambition level* for learning orientations and for generation of repositories of narratives as a basis and input for the learning and adapting organization.

As a TORC training program depends on the specific context in which it is applied, e.g., rail, oil and gas or air traffic management, the training design for each case must be set up separately. If TORC is applied in different application areas, the usability of the TORC concept must be specifically assessed, guided by D1.1, resulting in a company oriented Training Strategy.

It is in any case recommended to structure the training goals in terms of a capability structure related to specific company services (see Figure 4), e.g., maintenance or air traffic services, and define use cases as links.

Specifically, in order to ensure sustained coherence with TORC premises throughout the training program, it is recommended that the TORC objectives and sub-objectives (Table 1 in D1.1, page 21) are used to reflect the strategic objectives for the resilient organization. The proposed Training Targets of D1.1 are reiterated in Table 2 below, supplemented by a more practice-oriented exemplification of presumed needs of a "generic" training client (note that these are meant as illustrative examples, not as exhaustive specifications).

Learning from adaptive practices also implies to recognize which experiences, patterns and reflections that need to be communicated for adaptation in a wider context than their origin (e.g. in terms of change strategies, rules, SOPs, training development, etc.). In this respect, the self-imposed ambition of the TORC approach to urge for "thick" descriptions, that is, urging not only for facts but also of commentary, interpretation *and* interpretations of those comments and interpretations, may be challenging to meet.

Theoretical and other scientific material (e.g., on Resilience Engineering) may also offer inspiration and options for action (as well as for interpretation and comment). In the TORC project, a number of theories[28] have been considered in terms of the support they offer to the company use cases in terms of identifying strategies applied, resilience competences to be explained etc. Findings from this is reflected in the TORC Gaming Training format (see chapter 4 in this report), which is "energized" partly by Resilience Engineering principles (see Grøtan et al., 2016).

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[26] E.g., for an offshore petroleum production, R1-R2 will be the expected range, as any "flavor" of R3 will immediately be transformed into an emergency situation,

[27] See Table 1 (p23), and D1.1

[28] The TORC project learned that this comes with a cost, but enriched understanding of operational practices and context helped to highlight potential use cases. These sources were used as examples and references while developing the TORC concept.

Table 2. List of possible Training Targets

TT-ID	Training Target
A.	**Ensuring sensitivity to the WasI[29]/WasD[30] gap** Be aware of situations, in which work planning may not be sufficient to deal with unforeseen operational demands
B.	**Ensuring sensitivity to "decisive moments" and demands that spark explication, interpretation and sensemaking**. Be aware of a changing operational situation, acknowledge the need to change the current comprehension of the situation and the work strategy, and make these new orientations explicit in order to organize the relevant communication with respect to changes in work (alternative strategy, additional resources) and governance.
C.	**Ensuring ability to display "adaptive intention" to surroundings and co-workers** Organize decision-making and cooperate with relevant stakeholders, decision-makers or providers of resources to adapt the (new) work strategy and prepare alternative action.
D.	**Ensuring sensitivity to adaptive traps** Understand unwanted outcomes of consecutive adaptations and anticipate potential crossing of safety boundaries without adequate controls
E.	**Framing of local/situated "rudimentary resilience"** Be aware of and able to address competences in individuals, teams and organizations. Understanding the need for, and providing the mandate for space of maneuver and any supplementary strategies, competences and resources needed for adaptation.
F.	**Ensuring the ability to deal with the changing imperatives of increasing CvR ratio** Be aware of resilience capabilities and potential, and the need to grow and train these to a level at which 1) the need for capability to anticipate and adapt work practices is understood, facilitated and prepared, and 2) the ability of the organization to learn from experience and evaluate resilience over time and of situated cases has become the prevalent practice.
G.	**Ensuring the ability to deal with non-linear development of "graded[31]" resilience** Be aware of resilience capabilities and selecting a suitable mix of resilience "grades" to manage deployment of resources and act resiliently at individual, team and organizational level in accordance with situational needs and dynamics.
H.	**Ensuring the ability to attend to the Law of Stretched systems.** Recognize and manage the space of maneuver close to or beyond the dynamic boundaries. Dynamic boundaries originate from regulatory or company-specific expectations, but changes as a result of adaptive behavior close to those boundaries • Awareness of boundaries: what boundaries[32]exist (dynamic and shifting boundaries)? Continual re-assessment of boundaries and awareness of different perceptions on this. • Continually assess the 'safe operational envelope[33] '.
I.	**Ensuring field staff support to provide feedback about a resilience experience at the sharp end** Reflect on experience with adaptive practices, provoke dilemmas encountered, learn from successful or unsuccessful behavior to remember strategies applied for direct or future learning (resilience repository) reference
J.	**Ensuring the ability to signal necessary adaptations at organizational level to analyze feedback through after action review.**

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[29] "Work as Imagined"

[30] "Work as Done"

[31] Grade may sound hierarchical but can be a continuous scale. In this report, it is exemplified as four modes: R1-R4. See Table 1

[32] Boundaries may sometimes be rather fluid

[33] Dealing with its boundaries and putting conditions in place to do so (e.g. think ahead about what decision-making processes including escalation levels and their context would look like if you need to challenge the envelope during normal operations or in a crisis) is part of the resilience domain.

2.2.2 Consolidating and priming the compliance base and safety management

It is a prerequisite for the TORC training that procedures are in place for the operational contexts (e.g., use cases) that will be designated for training. This "compliance base" is the foundation and starting point of the training. However the preparation of the training and the evaluation of the training may – and will seek to - highlight areas of improvement of the procedures or other processes defined in the safety management system.

It is important to note that the TORC approach is not intended to legitimate a perfunctory or "voluntary" stance at the procedures, nor the lack of adequate procedures. Resilience in TORC terms is a means for *supplementing* additional procedures (implementing resilience capabilities) when needed, and for identifying and elaborating modification of procedures when needed and in coherence with adaptive capabilities. Our scientific term for this is "CvR reconciliation" (see ref. D1.1).

Hence, the "compliance base" must be established (designed, known and trained) before TORC training can commence. Moreover, when developing the training, the potential of learning to learn should be in focus as well. E.g., how can the trained organization learn from experience and findings during training and can the training already deliver input for a "resilience repository" in terms of descriptions and narratives exemplifying resilience.

In preparing and implementing the training both hindsight and foresight are necessary, hence the process needs to comprise:

- *Rubbing*: recognizing situations where the rule is not sufficiently effective and explicating resilience experiences (known improvisations/adaptations)
- *Maneuvering*: acting upon the need for adaptation space beyond compliance
- *Adapting*: effectuating the opportunity for adaptation, facilitation, i.e. 'hard' conditions (parameters for decision-making) and 'soft' conditions (e.g. no-blame/ just culture)
- *Learning*: capturing what was learnt in stories, training, information repositories
- *Accommodating*: prompting double-loop learning (close the gap between work as imagined and work as done in the formal systems).

As far as possible, any "hooks and probes" specifically facilitating adaptation and deviance in the procedures, and in the safety management system in general, that can be used to facilitate and leverage resilient performance must be identified, reinforced or added. *In fact, exercising them could be one of the very first training elements*. There are several practical ways to organize this, some are suggested by Lay, Branlat and Woods (2015):

- Real Time Risk Assessment (RTRA)
- "2-minute drill"
- "Lightning round"
- "Human performance coaching"
- Operationalizing margins of maneuver (e.g., by sharing limited resources; reconfiguring resources to meet emerging demands).

The "PEEL" (Prepare-Execute-Evaluate-Learn) approach of Eni Norge is a similar practical example of this. PEEL accommodates the first three steps of Lay et al. (2015).

Moreover, a basic pattern of (real) *interaction between sharp and blunt ends* on (really) critical and controversial matters must also be in place. The STICC approach (Figure 6) for briefing conversations

(Sutcliffe, 2011) is an example of how management can "open the(ir) door" for an inquiring conversation to explore the next step when resilient capabilities need to come into place.

The STICC approach to briefing conversations

S = Situation	'Here's what I think we face'.	
	The leader summarizes the current problem or issue.	
T = Task	'This is what I think we should do'.	
	The leader explains their plan for addressing the problem.	
I = Intent	'Here's why'.	
	The leader provides the rationale behind their plan.	
C = Concern	'Here's what we should keep our eye on'.	
	The leader identifies potential issues or problems that could arise in the future.	
C = Calibrate	'Now talk to me'.	
	The leader invites feedback or questions.	

Figure 6. The STICC approach to briefing conversations (Sutcliffe, 2011)

One of the main tasks for management is to govern the organizations confidently back and forth through situations in which their overall "balance" is shifting (as depicted by the slope in Figure 7).
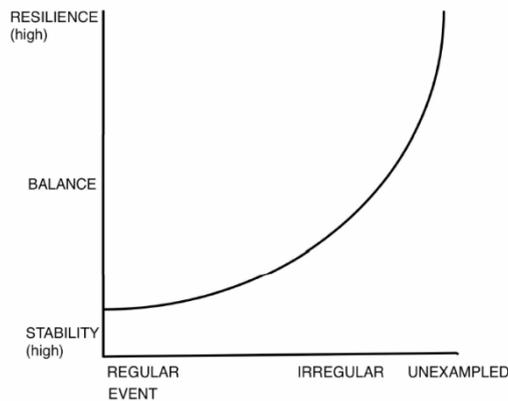
Figure 7. Balancing resilience and stability (Lundberg & Johansson, 2006)

In TORC, this is conceptualized in terms of enabling a "sliding window" that activates different underlying orientations or "modalities"[34] of resilience in increasingly irregular situations of increasing CvR ratio (Figure 8, see also D1.1). Hence, there is also a need for a framework in which management can gauge different levels and modalities of engagement from/by the sharp end, and calibrate their own interactive contribution correspondingly.

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[34] Namely explication, interpretation, sense-making and improvisation, see D1.1

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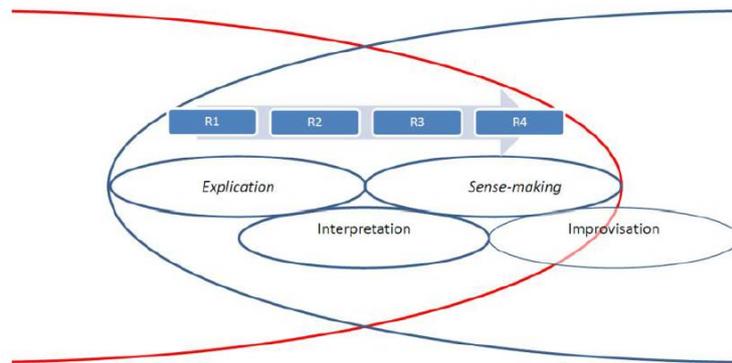
Figure 8. Underlying TORC "modalities" of resilience, demanding differentiated managerial governance

The "anomalizing" approach (Barton et al., 2015)[35] as well as the ADAPTER approach (Van der Beek and Schraagen, 2015) are examples of frameworks that more directly facilitate managerial interaction with a variety of operational conditions. Such frameworks are especially promising for *integrated training*.

A basic condition for consolidation and priming to take place is that not only safety management, but also overall management appreciate the value of the resilience contribution. Hence, the benefits of the concept of resilience need to be explained with an eye on the specific company operational experience. The needs and justifications of potential resilience capabilities may be explicit or implicit. It will depend on sound analysis of operational dynamics and experiences with disturbances and variance in normal operations. This requires an open mind to understand informal and formal behavior and possible gaps between works as imagined and work as done. When the conclusion is that present procedures and competence no longer suffice to cope with future demands, or informal and tacit practice need to be come explicit and manageable, the *resilience in context* concept offers a pragmatic perspective, and TORC offers a prospect for the necessary change process.

An external provider of TORC training may play an important role with respect to sharing or raising awareness amongst internal company stakeholders of the resilience perspective and prospect.
The TORC project behind this report has been based from the start on liaising research and industry partners, combining their present awareness and needs. This experience of the TORC project is therefore made available and formatted as an example for future TORC training providers.

 The result of this step is:

- Partnership for TORC training
- Training anchored in the company policy and safety program to optimize space of maneuver in the face of compliance
- Commitment to invest in development and understanding of knowledge and resilience practices in the context of the company
- An open mind to acknowledge the (dis)advantages of a strict compliance policy
- Training Targets explored and selected
- A defined project to manage the development and implementation of the TORC training.

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[35] Here, the managerial role is denoted "contextual engagement"

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2.3 Intake and familiarization process

The mutual exchange of knowledge and experience between the trainee organization (company) and the training provider[36] is essential. This is initiated by organizing an initial, local kick-off meeting. The next step is for the training provider to familiarize with the primary processes, the employees and any associated risks and challenges the training recipient (industry partner) faces. For this purpose a review of company documents is conducted and interviews are held based on a semi-structured interview format which includes topics addressing factors associated with (team) resilience and compliance (see Table 4). The interviewees will also receive an introduction to the TORC concept.

A designated representative of the company (TORC contact) should be appointed and be present during the introduction to assist the training provider. During the introduction a series of semi-structured interviews is held with a cross-section of the recipient's employees. At the end of the day the provider team reports the results back to the recipient's management.

The result of this step is:

- A shared comprehension of existing resilient practices of the client (trainee organization), including a joint assessment whether they are only rudimentary, somewhat shared and appreciated, or already resembling some characteristics of a resilience capability
- Exchange of ideas and agreement on specific issue the trainee organization (company) wants to have addressed in the training (e.g., what steps in the project should be in scope and does it include work preparation?)
- A definition of use cases to be identified and looked for to give input to the training development
- Understanding of use cases and resilience practices in operations
- A common theoretical basis (main TORC concepts, terms and definitions etc.)
- A basic repository of insights, documents etc. for inspiration and input in the training development.

Further working arrangements are made with the company's TORC contact and agreements are made for handling of confidential data and the buildup of the project repository. It is also recommended that a search for persons that can be instituted as "insider trainers/mediators" is incited as soon as possible.

2.4 Working methods to support the familiarization process

2.4.1 Selection of people to be involved in the project (company[37] focus group)

To cooperate and develop in close cooperation with the client company, a selected group of people (focus group) is necessary to support analysis and development of the TORC concept. This group can also act as sponsor for the promotion of the training and organize commitment and sponsorship to the TORC project. Typical personnel involved are:

- Operations management
- First line supervisors

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[36] In the TORC project producing this report, the training providers have been research institutions. Due to the complexity of the TORC approach at the present stage with scarce piloting experience, this arrangement might be beneficial also in future cases

[37] As noted earlier, the term "company" is used interchangeably to carry the meaning of the more generic terms "client", "industry partner" or "trainee organization"

- Representatives from field staff with firsthand knowledge about the working processes affected by training
- Safety delegate
- HSE manager/expert
- Trainings manager/expert
- HR manager

The group selection should have the following concerns in mind:

- Cooperation with dedicated group of people
- Support for development and implementation of training
- Resources for knowledge and experience of company affairs related to TORC training

2.4.2 Explorative interviews and (mini) workshop

A next step is to identify proper use cases in order to identify practices and experience that can be associated with resilience, e.g., coping styles of operational teams when facing disturbances in normal operation. Location and date for interviews and workshops should be scheduled in consultation with the company's TORC contact. The company's TORC contact is requested to reserve rooms where interviews can be held in confidence. An example of a workshop program is given in Table 3. Some remarks on possible motivation are stated in italics.

Table 3. Example of an intake workshop at the company premises

Time	Training	Participants & facilitation
08:30 – 09:00	Kick-off: introduction and planning.	Attended by company management, HSE and HR management (possibly including employee representatives/Works Council/Safety Delegate). Chaired by project manager. *Leaving them out here would make it a hard sell in operation as they have existing agendas. You need their buy-in*
09:00 – 09:30	Meeting with training specialist	*Joint buy-in is established at the right level together with the HR & HSE manager to share training policy and targets and any reservations on practical constraints.*
09:30 – 10:30	Mini workshop compliance vs. resilience.	Company attendees in collaboration with company TORC contact. Facilitation by the research team. *Interests of a safety delegate may differ from those of 'ordinary' employees. Bias to management interests in the starting conditions is a risk. Differs per company.*
10:30 – 12:30	Interview(s) on organizing for resilience with company management, operations management and HSE management.	Prearranged management interview sessions conducted by the research team. Early workshop results can serve as a reference. *Maybe also invite HR management for inclusion.*

Time	Training	Participants & facilitation
12:30 - 13:00	Lunch	
13:00 – 14:30	Workshop discussion of compliance documentation and explore ambiguities.	HSE Manager, 2-3 hands-on experts from operations, research team. Early workshop results may serve as a reference. Facilitated by the training provider team. *Workshop idea: select critical decision points and resilience aspects around those (on the floor incl. horizontals / vertical management involvement) to keep it manageable time-wise.*
14:45 - 15:15	Discussion of the 'use cases' made available beforehand in preparation of the next session / future training.	Attended by the HSE manager and the TORC company contact. Facilitated by the training provider team.
15:15 – 15:45	Consolidate preliminary results.	Company contact and research team.
16:00 - 16:30	Close-out: presentation of preliminary results, discussion and way forward.	Attended by company management, HSE and HR management (possibly including Works Council). Chaired by the project manager.
16.30 - 17.00	Evaluation and discussion on working arrangements	Attended by the TORC company contact and the training provider team.

Obviously, the workshop program example is ambitious and can be adjusted. The attendees included in the schedule are typical roles related to safety. If the scope of resilience is extended beyond safety, other specialists, e.g., on general training and human resources management, can be included. The intention is to have the participants represent a good cross-section of the roles involved in decision making at different levels, relevant for resilience in a broad sense.

Outcomes of the explorative interviews and (mini) workshops:

- A "hands-on" feeling with company dynamics and climate
- Common understanding of resilience capability concept
- Strengthened understanding of compliance vs resilience (CvR) reconciliation
- A "taste" of the company compliance and safety culture
- Wish list of use cases to be found and documented
- Working arrangements for training development.

2.4.3 Document scan/review

In other to understand the compliance regime of the company and its safety management system it is necessary to get an overview of and some insight in:

- Management ambition and vision
- Policies on rulemaking and rule management
- Policy on resilience and empowerment/mandate of first line supervisors and field staff
- Hierarchy of procedures and instruction
- Experience with rule breaking
- Relevant legislation and critical stakeholders from compliance perspective
- Training process and program.

The company is requested to provide a set of relevant documentation illustrating the way their management system operates, what safety and compliance policies are implemented, relevant operational procedures etc. This documentation is studied in preparation for the in depth interviews with key people and workshop

As an example, Table 4 lists the documentation that may be requested by the training provider team prior to the interview (if available and released for dispatch).

Table 4. Possible sources of company information relevant for understanding company operations

With regard to		
Management issues	-	The corporate governance and safety policy of the company
	-	Experience with non-compliant situations and follow up (e.g. are sanctions considered for breaking rules) company culture and management rule breaking,
	-	Contractual agreements with (and documented influence of) suppliers
	-	The latest management review report
	-	Investigations by clients (safety culture ladder, compliance audits, etc.)
	-	Organisation and key processes or responsibility charts e.g. a RACI[38] if available; decision support systems, decision processes, ways of tolerating or mandating response to unexpected events, the decision-making structure, formal hierarchy and decision authority)
	-	Other information considered relevant.
HR Management issues:	-	Overview of training policies, safety training and training matrix of the company and evaluations of training effectiveness
	-	Process description on how learning experiences (desirable / undesirable) are dealt with, documented and followed up (learning organization at team and organization level)
	-	(Effectiveness of) sanction regime
	-	Documentation on how the organization stimulates or rewards worker/team initiative and proactivity. (e.g. assessment policy, capability development, best employee recognition, team debriefings, space of manoeuvre for workers)
	-	Other information considered relevant
HSE management issues:	-	Safety culture measurement results, methodology and response

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[38] Responsibilities, accountability, advisory and information lines

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With regard to		
		(feedback/actions)
	-	Methods and procedures to receive and respond to signals from employees based on experiences and worries related to work, regularity of team debriefings, ditto decision support to field workers
	-	Overview of relevant compliance documents representing examples of operational experience and rules
	-	Key SOPs applicable to cases provided.
	-	Explicit and implicit demands having led to noncompliant or resilient behaviour
	-	Insights in top risks, vulnerabilities and safety issues, risk monitoring and response to change

Outcomes of the explorative document scan:

- Overview of essentials in rule management
- Insight in relevant procedures
- Overview of relevant incidents
- Insight in applications of compliance policy and sanctions
- Understanding of actual training targets, program and planning.

2.4.4 Selection of use cases, scenarios and possible capabilities

Identification of use cases and scenarios is needed to identify prerequisites and ensure a good understanding of the operational contexts for TORC training. Client's use cases are derived from everyday operations and past incidents. Both incidents that lead to damage (negative outcomes) or not (positive outcomes) are important since they both may indicate past resilience dynamics.

One or two use cases should be selected for use in piloting the TORC training prototypes. The selected cases will be analyzed in depth to determine the relevant aspects for the training types aimed at the three application contexts (operations, management, integrated).

If practicable, it is recommended that the scenarios and use cases are contextualized as early as possible in terms of a (service delivery) process from which a need for a resilience capability can be derived (Figure 4), including a prototypical description of demand and expected output (Figure 5). However, the TORC framework is designed to facilitate the targeting and development of more generic resilience capabilities and associated strategies, resources and competencies, also in the case that such use cases are not imaginable from the outset of the training.

Outcomes of the case inventory:

- A joint point of reference to understand and synchronize views on resilience in company practice
- A portfolio of cases with "wrong/unwanted" and "good/welcomed" outcomes
- Insight in relevant actors in cases with presumed adaptive practices.
- A priori prospects of how use cases and more elaborate scenarios can be developed into capabilities

2.4.5 Interviews with key employees

Interviews are conducted to assess the current perception of resilience and adaptive experience in the organization. Also the company culture will be explored:

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- Does the company have a just culture?
- How (strict) is the compliance policy maintained and enforced?
- Is the culture open and transparent?
- Are there any "taboos" with respect to compliance?
- What are leadership styles?

Interviews may take place with supervisors, safety experts and employees from operations. Suggested topics addressed are listed in Table 5. A full interview program is included as Annex 1 Semi-structured TORC interview .

Table 5. General topic for intake interview

Theme	Topics to be addressed
Risk awareness	• Understanding: does the team establish common ground / common mental image of the situation, including other decision makers (distributed cognition)
	• Anticipation: recognizing and addressing drift in anticipation
	• Attention: assess response to signals and changes
Adaptive capacity	• Responding when procedures no longer help
	• Coping strategies – adaptive behaviors applied in practice
Available support	• Decision support by management
	• Decision support systems and criteria
	• Available redundancy
Facilitation of learning	• Learning organization features
Outcomes	• How do the team/ organization respond if a procedure no longer works?
	• How is the organization equipped to this?
	• How can additional resources be activated?
	• What strategies are followed or introduced?
	• What is the follow-up by the organization when rules were broken?
	• What kind of evaluation or after action reviews are implemented?
	• How does the organization learn from this?

The expected outcome of the interviews is enhanced insight in:

- What dilemmas between resilience and compliance are experienced?
- Are conditions OK with respect to sensitivity for openness and transparency?
- Is there a sense for awareness of resilience concept and practices?
- Problem solving tactics in operations?
- How does organizational learning work in the company?

2.4.6 In-depth workshops on location

The goal of a workshop at the company's premises is to elicit the potential gap between the formalized safety management system (e.g., procedures and the way in which they are updated) and informal practices by taking an in-depth look at several aspects of preselected use cases (assignment, goals, roles and responsibilities, etc.). Generally speaking, the use cases should at least cover one so called 'normal operations' scenario that (might) have escalated into severity or crisis, and an emergency scenario. Through several questions, more details are retrieved on case specific events, goals, actions or failures to act, effects

of strategies used, etc. All serves as input in order to develop the Training Elements and explore relevant Training Targets based on real-life domain-specific cases. Typical participants of the workshop are:

- Field staff partly involved in the cases
- First line supervisor
- Operations manager
- Safety delegate
- Safety expert
- Training expert.

One or more (use) cases may be discussed. The following method were applied by TNO with the Dutch industry partners:

1. Introduction of the case
2. Explanation of the course of action in the case discussed is given by the participants (one or more actors actor present at the site during the event)
3. Discussion of experiences, decisions and points of view with the other attendees
4. Reflection on discussions by all present.

The attendees were requested to take on the role that they actually had in the case or the role they normally have and consider the case from that perspective. This allows for differentiation between considerations of various (management) team members during an unexpected event, which provides input to the design of Training Elements. Lack or excess of prior planning may be part of the discussion. Table 6 suggests more detail.

Selected use cases may be explored in more detail by inviting more employees in these use cases to the workshop. The purpose of this exercise is to create an improved understanding of the context in which resilience and compliance co-exist in practice, and for preparation of suitable training. In preparation of this workshop, the company may be requested to provide more elaborate information on the selected cases which is necessary for adequate preparation and drafting of a meeting agenda. Also supporting material is important to be included in the training later on to illustrate the case: photos, layout drawings, process diagrams etc.

Outcomes of the workshop are:

1. Improved understanding of the context in which resilience and compliance co-exist in practice
2. Content and illustrations applicable for preparation of training.
3. Insight in the kind of strategies, resources and competences that are implemented in the company use cases and similar activities/situations.
4. Specific assumptions on content in training development
5. Predefined training elements may be tentatively proposed and discussed.
6. Suggestions of improvements that have come up during the discussions may either be used to revise the compliance base (procedures), or be included in the list of proposed strategies in training situations (and thus being validated through training). Their later inclusion in the compliance base may then be regarded as an example of "CvR reconciliation" (see D1.1)

Table 6. Example of TORC explorative workshop format

Case	Issues to explore
The first case is presented and the discussion is guided by means of exploratory questions:	1. What was the assignment?
	2. What exactly happened / who had what role?
	3. What information did you have / or didn't you have?
	4. What did you hear, see or smell (sensory information)?
	5. What rules, procedures and requirements were applicable?
	6. Was the planning beforehand as adequate as possible there and then? (avoid hindsight bias here!)
	7. How did the information exchange, cooperation and communication go?
	8. What were your (prior) goals and considerations before you took action?
	9. How did your goals and role change during the event?
	10. How did the team act during / after the event? What strategies did you consider / were available to you?
	11. Which previous training /experience were useful in making decisions?
	12. What was the effect of the approach (local and to the organization as a whole)?
	13. How was the experience shared afterwards (in the team and beyond)?
	14. How have you benefited from resilience practices?
	15. What would you do differently next time?
	16. Summary of findings and articulation of resilience versus compliance issues.
The same routine is applied for the second case. The case discussions are followed up by an overall evaluation guided by questions such as:	1. Are there remaining issues or is there other information not yet discussed?
	2. How often do you discuss similar cases in this way?
	3. What are your thoughts about this approach of elaborating in detail on event cases?
	4. Might this be an idea for training development (maintenance personnel / managers / combination)?
	5. Is there anything else you would like to share with us?
	6. What was interesting about this exercise and what was not?

2.5 Identifying target group and start-up communication on TORC project

The company's TORC contact is requested to identify a target group for TORC training in detail. Management and the selected employees should be informed about the purpose and context of the upcoming visit, and the confidentiality to the employees that will be trained should be highlighted.

The results of this step are:

- Selection of people to be trained: management/corporate staff and field staff
- Communication plan on training goal and planning
- Communication of training set up
- Necessary preparation of the personnel (on collective or individual basis).

2.6 Tentative training plan

During the sensitization process a tentative training development and implementation need to be developed:

1. Tentative set up of targets group for training
2. Tentative portfolio of uses cases providing input for training sessions
3. Training Strategy to be agreed
4. Training Elements to be selected and Formats to be developed
5. Training program and date to be fixed

The expected results of this step are:

- Agreement on the way to work
- Resources available to allocate to development
- Resources available to conduct the training.

The sensitization process will be ongoing and reinforced by the training per se. The next chapter will describe how the training as such may be planned and developed.

3 TORC Training development

Once intake and familiarization is finalized, relevant employees (e.g. operational staff) are informed and the ambitions and targets of the TORC training program and sessions are set, tasks can be further planned and organized. During the intake and sensitization process, ideas and the contours of the training have been collected and tentative set-ups of the training have been developed, modified and sometimes skipped. The following description of the training development is an idealized way of working in order to support the development process of the training content.

A typical set-up for a TORC-based training development program is as follows:

1. Operationalizing the scope of training
2. Prepare detailed training plan
3. Conduct training
4. Evaluate training
5. Close training project and give guidance for further work

In the following, each issue is given a brief presentation.

3.1 Operationalization of scope of training

The operationalization of the scope is an iterative process being anchored in the initial intake and sensitization process.

After the first encircling of past experience (e.g. resulting from interviews, workshops) it is recommended to use the TORC Training Targets, see Table 2, as inspirations and ideals, and associate them with company needs and ambitions.

3.1.1 Explore scope and targets of operational, managerial and integrated training

The scope should preferably be expressed in terms of the actual pragmatic field of application, that is, in the operations of the industry partner. A selection of possible industry client environments (illustrated in Figure 9 to Figure 13) reflect the industrial engagement in the TORC development process behind this report, and thus also provides a (non-exhaustive) indication of the span of application for TORC.

The scope builds on a number of elements, e.g.:
- Teams/shifts/crews that can be identified
- Phases in business process: preparation, operations, maintenance, emergencies
- Specific disciplines to be involved
- The level and kind of management involved

Figure 9. Heavy rail maintenance

Figure 10. Asset management, high speed railway infrastructure

Figure 11. On shore use case oil and gas operations

Figure 12. Offshore oil production, storage and offloading

Figure 13. Air traffic management

The point of departure for targeting TORC should be that *operational and managerial* training should commence by focusing on simulating real life cases likely to provoke necessary resilience capabilities (strategies, resources and competencies), while *integrated* training should be more exclusively focused on interactive patterns (e.g. mutual consultation, resources and decision support provided, gaps in perceptions of compliance etc).The integrated training can also aim for reflection on results and experiences during operational and managerial training, and specific gaps in approaches, decisions and beliefs.

However, both operational and managerial training should encompass illustrations, prototypes or simulations of interactive patterns when competences, strategies and resources are identified and raised, in which the (managerial/operational) counterparts may – if necessary - "proxied" by the training staff, or by other means.

Moreover, there will presumably "always" be a need for sustained managerial "intake" of operational "reality", that is, appreciation of rudimentary resilience or "work as done". Some managerial participation on operational training is therefore needed. The experiences from such participation should be subject for reflection in the context of management training.

The exploration of scope will result in defining a tentative Training Strategy as a starting point for developing the training content in detail. In the next step the selection and development of training content must be initiated in terms of:

- What operational strategies are relevant?
- What resources need to be identified, which coping to demand styles can be followed and enriched with resilience theory and concepts?
- Does the company need to address specific competence/skills as pre-TORC training?
- Is creating insight and awareness in resilience dynamics and coping methods enough to spark action and change?

The tentative Training Strategy will sketch working assumptions on:

- Scope
- Training Elements
- Training Formats
- Training program

Given these assumptions the training content is developed.

3.2   Development of TORC training content

In order to develop an initial set of Training Elements and applicable Training Formats, the TORC development project has explored several concepts and theories. This has been an interactive process with theoretical experts and practitioners and experts of the companies involved.

Several sources and inspiration has been explored. E.g., during the TORC project one of the leading experts on resilience engineering, Professor David Woods, was invited in a workshop with research and industry partners to explore the concept of shifting competence envelopes and resilience modes in more detail.

3.2.1 Sources and inspirations of functionality addressed in Training Elements

The TORC rationale and Training Targets (D1.1) is the recommended point of departure, however a variety of sources and inspirations for intended and required capabilities is conceivable. Preferably, they should be translatable according to the "double hermeneutic" premise described in D1.1 (that is, they serve the purpose of "supporting the understanding subject" rather than "explaining the actors as objects"). Examples of such inspirations are:

1. Hollnagel's (2009) four cornerstones of resilience is an obvious starting point[39].
2. Feedback/feedforward loops derived from the FRAM (Hollnagel, 2012) approach can also be applied
3. Implication of the "Law of Stretched Systems" and elements from the "basic rules of the adaptive universe" as presented in a draft version by D. Woods (2015)[40]

In principle, according to the TORC Capability Structure, the selection of Training Elements should encompass and engage:

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[39] As will be seen below, the CSF (Størseth et al., 2009) approach used to depict the *adaptive clusters* (Grøtan, 2011) is commensurate with the four cornerstones (Hollnagel 2009)

[40] Note here that implications of "the Law of the Stretched Universe" and the four conceptualizations of resilience (Woods, 2015) is already embedded in the TORC approach, objectives and training targets

a. Resources and competencies (skills, knowledge and attitude) that are essential ingredients in the prospected resilience inventory
b. Strategies, heuristics and interactive patterns that are needed to transform the inventory from parts into ("live") capabilities*;*
c. Organizational enablers and "lubricants" that may reinforce, amplify or sustain the process of leveraging and implementing a resilience capability.

It is recommended from the outset to use the capability concept as a designated tool to aim more precisely and distinctively at situated resources, competencies and strategies and patterns of interactions that are reasonably coherent with the selected *use cases and scenarios*, including the specification of prototypical sets of presumed demands and preferred outcome (see Figure 5).

3.2.2 Exploring the capability concept

Resources

Resources to be considered are based on a multilevel resilience model developed by TNO. Resources are expected to be found:

- At individual, team and organizational level
- In people and assets
- As information and communication structure of the company
- In the management systems (quality, safety).

To organize a resilience response, time is considered as a crucial resource as well.

For the TORC training these resources are thus summarized as:
- Information and methods
- People
- Assets
- Communication and liaisons
- Time

Strategies

Strategies to consider are proposed in Annex 2 *Resilience strategies and tactics (patterns, heuristics) (to transform "resilient inventories" into "resilience capabilities*". The origin and process of (trans-)forming these is described in Grøtan et al. (2016).

Competences

For operational competences it is recommended to consider:

- Task preparation, ensuring that relevant "hooks and probes" in procedures are actually recognized and taken into use
- Communication for the purpose of shared understanding
- Assessment check
- Elaboration of possible future effects
- Information sharing (displaying intentions when deviating from procedure)
- Making decisions, acting

- Ability to "anomalize" (seemingly normal) situations; that is, engage in abductive thinking (does the observation mean something else, or more than habitually expected?)
- Exercise the different TORC "modalities" of explication, interpretation and sense-making : bringing resilient practice to the fore, expressing the necessary operational margins
- Communication and collaboration (procedures, decision support tools)
- Reaction to exceptional circumstances (leveraging and engaging strategies and heuristics, recommended patterns)
- Collaboration in general
- Learning capacity (rule-centric, adaptation-centric and/or reconciliation-centric)

For managerial competences, it is recommended to consider:

- Rehearse the "positive" view; appreciating the (actual) adaptive contributions
- Support sharp end in extraordinary situations
- Ability of *contextualized engagement* in anomalizing (flexibly supporting both explication, interpretation, sense making in hypothetical and real situations, see also Figure 8, p26)
- Revising operational training accounts and engage in after-action reviews in a critical-constructive way
- Assessing (and describing) operational spaces of maneuver
- Create a climate of openness, trust and justice to facilitate an open mind when dealing resilience reconsolidating with compliance.

3.2.3 Exploring and prototyping tentative interactive patterns

It is recommended to sketch out some interactive patterns that can be associated with the use cases, and that engage both the sharp and blunt ends. An interactive pattern is an operational characteristic of a resilient strategy, engaging resources, competences and skills of the actual organization of the training client, across operational and managerial domains. When sufficiently mature, an interactive pattern may accommodate most of the inventory and dynamics of a resilience capability.

Resources, competences and strategies may vary substantially across industries and companies. For the purpose of inspiration and incitement, a more generic and theoretical approach is described in the following.

The basic idea is the presence of an *inventory* of properties or building blocks of resilience, and the occurrence of *adaptive clusters* which are dynamic formations of inventory parts, responding to the actual situation or demand. The *inventory* used for exemplification here is based on the Contributing Success Factors (CSF) model by Størseth et al. (2009), while the concept of *adaptive clusters*[41] is based on the Response-Execution-Leverage (REL) model (Grøtan, 2011), building on the CSF model. The CSF model approach is consistent with Hollnagel's (2009) four cornerstones of resilience, but not identical.

Hence, the CSF/REL combined approach may be used for framing prototypical interactive patterns that engage resources and competencies across (operational, managerial) domains in a joint dynamic scenario.

Such prototypical patterns can be extended into richer and "thicker" descriptions as illustrated in *Annex 2 Resilience strategies and tactics (patterns, heuristics) (to transform "resilient inventories" into "resilience capabilities".*

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[41] The basic idea of the REL model could be combined with FRAM modelling (Hollnagel, 2012), but that would imply a level of complexity that is beyond the scope of TORC training

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Moreover, the CSF/REL approach can be used as a generic tool to capture and document adaptive episodes already known to the organization. An example is given by Grøtan (2011) in which the anticipation of one peripheral actor possessing rich and crucial risk understanding silently incited a rearranged resource distribution (on vessels in the North Sea). When the incident actually was alarmed later on, resourcefulness (critical firefighting resources) was already reinforced.

The (response-centric) REL model is illustrated in Figure 14, signifying that a series of responses of actors is incited via a dynamic of risk understanding, anticipation and attention, while relying on robustness, resourcefulness, rapidity, decision support and/or redundancy for effectuation.
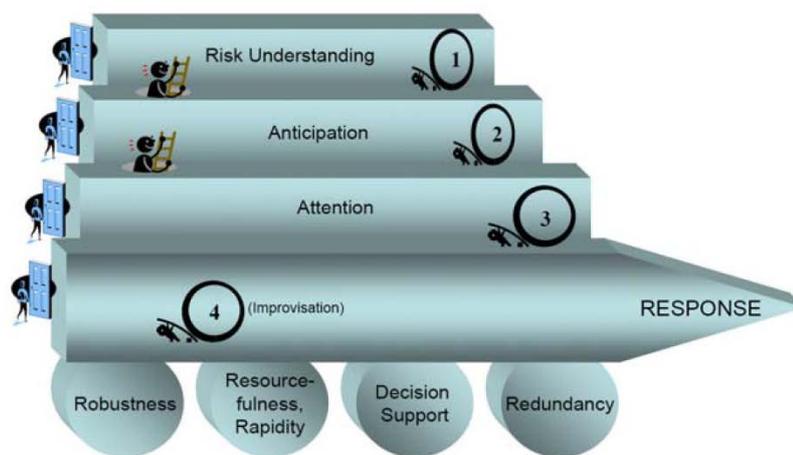
Figure 14. REL model

3.2.4 Identify enablers that should be included in the Training Strategy

In preparing and communicating about the training content it is a prerequisite to:

- Include existing supportive programs in the company. Clarify the impact on resilience
- Emphasize positive organizing[42]
- Promote a just culture of trust
- Provide a training climate securing confidentiality when needed to discuss dilemmas
- Keep an open mind by supporting and understanding individuals who have explored boundaries and possibly were faced with the dilemma, e.g., bending a rule for the sake of safety.

3.3 Developing a detailed Training Strategy

As far as possible, applicable and relevant, the training objectives and Training Targets (TT) should be identified from a common TORC base, and necessary add-ons described.

When starting the training development the tentative Training Strategy will assist as a framework and will comprise Training Elements (TE) and Training Formats (TF) related to the operationalized scope of training (above), their presumed sequencing as well as expectations of (prototypical) outcome and performance.

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[42] E.g., Sutcliffe et al. 2003

The tentative Training Strategy and the tentative training plan (see chapter 2.6) are then the basis for developing the planned training in more detail.

The following steps were followed when preparing the TORC-training for the industry partners in the development project:

1. Explore and decide on learning style
2. Explore and decide on type of training
3. Explore and decide on formats
4. Select Training Elements
5. Develop tentative training plan
6. Design a training plan
7. Design a Training Strategy for continuous development of the training concept in the context of the company resilience strategy.

In the long term the Training Strategy will evolve. If/when expectations and results of trainings and resilience practices starts to converge, a more formalized Training Strategy (TS) should be mandated, being anchored in Training Targets (TT) which may evolve with growing experience and trust in resilience capabilities. (See D1.1).

3.3.1 Learning style

The training plan should consider the most suitable learning style for the actual organization.
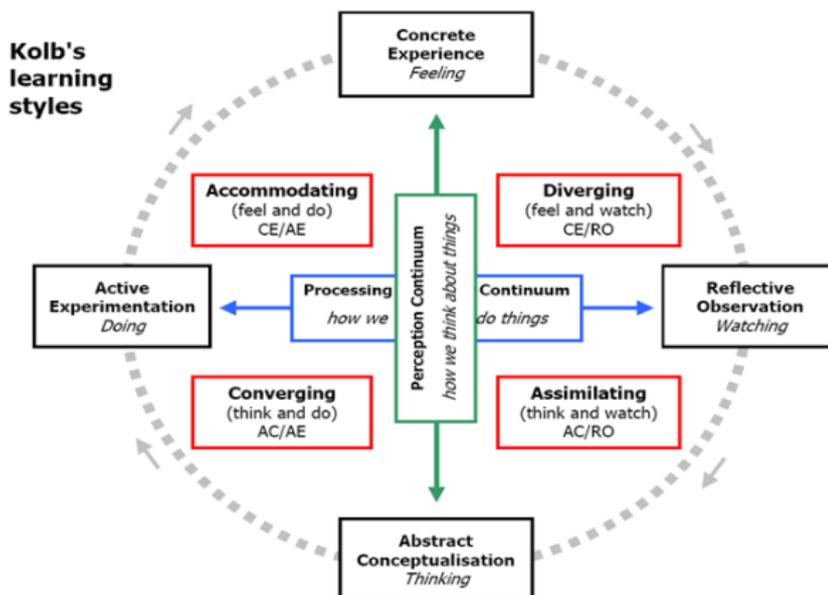
Figure 15. Learning styles of Kolb

For TORC training, the taxonomy of learning style introduced by Kolb (1985) in Figure 15 serves as a reference. Kolb suggested that a learning process often starts by taking particular action and then seeing the effect of his action. Since resilience is inherent to dynamically coping with demands (surprises, disturbances,

opportunities) it requires real time involvement of the trainee in a training context as close as possible to every day work.

TORC training is rooted in practical use cases. These cases are later on also used as a basis (e.g. for serious games) to provide a 'learning by doing' mode. In order to make the trainee aware of the resilience dynamic and have him or her understand the potential of resilience, an introduction of the resilience concepts is regarded necessary. By providing resilience (in context of compliance) as an overarching context for analyzing what has been experienced by "learning by doing", the quality of reflection on action will be improved.

Although resilience already have manifested for the cases presented, by re-experiencing them again, the team will improve their understanding of what resilience is and why it was taking place, and learn to signal scope for resilience in future situations.

3.3.2 Training Elements

The training plan should be stated as far as possible in terms of a set of Training Elements,

In the following, support is proposed for Training Elements related to aspects of:
- Learning to understand the need for shifting competence envelopes
- Learning to systematically review action alternatives to respond to demands
- Learning to facilitate team processes to assess situation and manage adaptive process

3.3.2.1 Shifting competence envelopes

A capability and its inventory may be associated with different maturity levels. Table 7 below offers an interpretation of the CSF approach (Størseth et al., 2009) across the R1-R4 space. It may be used (as functional abstractions of the inventory of an interactive pattern) to recognize and locate an interactive pattern across the R1-R4 space[43]. In practice, the functional abstractions of the inventory will have to be translated into the actual use case or context of the actual capability addressed.

This may be used both for designing Training Elements and exercises adapted to the actual aspiration level derived from the strategic resilience objective. E.g., while a "competence envelope" may be mandated at R2 from the outset, this approach can be uses to assess whether it requires also a partial inventory crossing that line, and for a joint assessment on the implications of that.

Table 7. Possible Training Elements related to CSF topics

CSF Theme	Statement	Reference / Comment
CSF1.1 Risk understanding	We have sufficient overview of relevant risk-related factors in the work operation	R1
CSF1.1 Risk understanding	Customary risk understanding is sometimes insufficient for anticipating potentially dangerous future events and states. Openness to new risk factors and signs is necessary.	R2
CSF1.1 Risk understanding	We are able to discover and understand that an unconventional situation indicates a (new) risk which is beyond the customary risk picture.	R3

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[43] As indicated in *Table 1. Summary of modes of resilience*

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CSF Theme	Statement	Reference / Comment
	We are prepared to indicate this *potential* new risk to our surroundings, even if it might turn out to be "false alarm"	
CSF1.1 Risk understanding	We are able to discover and understand that an unconventional situation indicates a (new) risk which is beyond the customary risk picture. We are prepared to indicate this *potential* new risk to our surroundings and directly to all potentially affected , even if it might turn out to be "false alarm"	R4
CSF1.2 Anticipation	We are familiar with the customary risk to a degree that we are able to identify potentially dangerous events and patterns in our system, even if they have not materialized before	R1
CSF1.2 Anticipation	We are familiar with the customary risk to a degree that we are able to discover new expressions and manifestations (e.g., in unconventional parts of the system)	R2
CSF1.2 Anticipation	We are able to conceive and anticipate a potentially dangerous situation, even if it cannot be derived from a customary risk picture	R3
CSF1.2 Anticipation	We are able to conceive and anticipate a potentially dangerous situation, even if it cannot be derived from a customary risk, and we are able to propose compensating measures immediately.	R4
CSF1.3 Attention	We are familiar with the expected course of a procedure to the degree that we are capable of recognizing a deviation right on spot, and thereafter take corrective action in a prescribed way.	R1
CSF1.3 Attention	We are familiar with the expected course of a procedure to the degree that we are capable of recognizing a deviating situation implying that the prescribed corrective actions are insufficient	R2
CSF1.3 Attention	In a deviating situation, we are able to decide whether the feedback from the system (and the associated procedures) are meaningful or misleading	R3
CSF1.3 Attention	In a deviating situation, we are able to interpret or make sense of new/unknown signals or feedback from the system, even if there is no procedural support for doing so	R3
CSF2.1 Response	In a predefined situation of deviation, we are capable to correct the situation in a standardized and prescribed manner, or if necessary stop the actual process according to given criteria	R1
CSF2.1 Response	When new potential situations or courses are revealed, we are able to describe precautionary or interruptive modes of response.	R2
CSF2.1 Response	When the situation calls for it, we are able to initiate an extraordinary mobilization of support from our surroundings.	R3
CSF2.1 Response	When the situation calls for it, we are able to initiate an extraordinary mobilization of support from our surroundings, and sustain this until the need is positively invalidated	R4
CSF2.2 Robustness	When the situation calls for it, we are capable of identifying, mobilizing and activating the resources that are planned and dedicated for corrective action until accomplishment, or stop of	R1

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CSF Theme	Statement	Reference / Comment
	process	
CSF2.2 Robustness	When the situation calls for it, we are capable of identifying, mobilizing and activating the resources that are planned and dedicated for corrective action or stop of process, withstanding the pressures from the surroundings which "lose" their resources.	R2
CSF2.2 Robustness	We are capable of implementing a planned corrective action, while at the same time experiencing extraordinary stress in a confined period of time	R3
CSF2.2 Robustness	We are capable of implementing a planned corrective action, while at the same time experiencing extraordinary stress in a sustained and indefinite period of time	R4
CSF2.3 Resourcefulness/rapidity	When unexpected situations occur, we are able to identify (new) problems, prioritize, mobilize resources and accomplish goals, provided that methods/procedures are described and made known in advance	R1
CSF2.3 Resourcefulness/rapidity	When unexpected situations occur, we are able to identify (new) problems, prioritize, mobilize resources and accomplish goals, even if all methods or scenarios are not described and made known in advance	R2
CSF2.3 Resourcefulness/rapidity	When unexpected situations occur, we are able to mobilize all conceivable resources needed, "just in case"	R3
CSF2.3 Resourcefulness/rapidity	When unexpected situations occur, we are able to mobilize/muster all conceivable resources needed, order "re-fill" of resources spent, and if necessary redefine or reemploy resources that are intended for other purposes	R4
CSF3.1 Decision support	We have predictable and standardized ways of access to decision support in situations that imply trade-offs between safety and other interests.	R1
CSF3.1 Decision support	In situations implying trade-offs between safety and (e.g.) production regularity, we are capable of, and gain support in, taking "big" safety-motivated decisions even if they affect production/regularity, and demand resources that affect other areas of functioning	R2
CSF3.1 Decision support	In situations implying trade-offs between safety and (e.g.) production regularity, we are capable of immediately mobilizing/mustering decision makers at "all" levels that might be necessary for decision support	R3
CSF3.1 Decision support	In situations implying trade-offs between safety and (e.g.) production regularity, we are capable of immediately mobilizing/mustering the correct and selected decision makers at "all" levels, and initiate extraordinary centralization and synchronization of decisions at several levels	R4
CSF3.2 Redundancy	In situations demanding reduced functionality in the overall system, we have clear, predefined alternatives and plans for controlled ("graceful") degradation.	R1
CSF3.2 Redundancy	The ability of the organization to withstand major functional degradations is pre-assessed and communicated.	R2

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CSF Theme	Statement	Reference / Comment
CSF3.2 Redundancy	In unexpected situations implying reduced functionality, the organization is able to mobilize/muster/activate all available resources that might compensate for critical lapse of functionality	R3
CSF3.2 Redundancy	In unexpected situations implying reduced functionality, the organization is able to mobilize/muster/activate all available resources that might compensate for critical lapse of functionality, dismiss unnecessary functions, while at the same time have unused resources in "hot standby"	R4

As indicated in Figure 16, adaptive clusters constituted in the *R1-R4 distributed CSF space* are not bound to a specific (Rx) level. Each adaptive cluster, signified by a closed circle, can span several levels. Each inventory part engaged is marked by a "star", and singular parts can also be strictly procedure-based. Moreover, different adaptive clusters can have overlapping inventories, and the inventory of a specific AC may be situated, executed or performed in different domains or contexts[44], e.g managerial or operational.

Ultimately, a shift of competence envelope may involve alternative strategies and/or interactive patterns to be implemented, and additional/other resources and competences to be deployed. This may imply an increase in the existing overall "level" of the AC. For example, an AC basically at level R2 may experience that the front staff's ability to anticipate something unknown (CSF1.2)[45] has evolved into level "R3". In order to capitalize this progress, it is necessary to take action such that decision support from management (CSF3.1)[46] must also be reinforced into "R3" (in order to have the option of mobilizing/mustering wider resources).
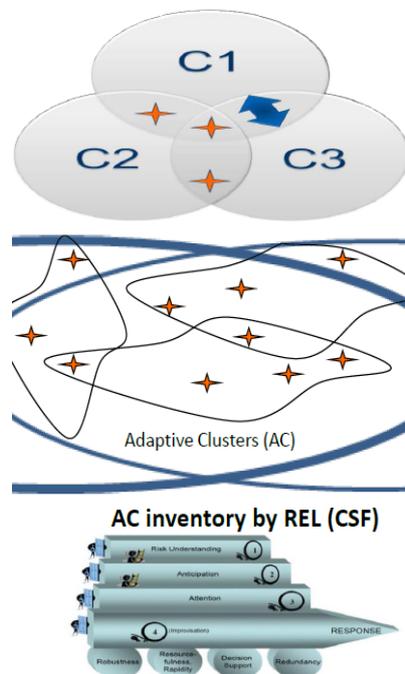
Figure 16.Adaptive clusters; overlapping inventories

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[44] In Figure 16, this is indicated more generically as "C1", "C2" or "C3"
[45] See Table 7
[46] See Table 7

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3.3.2.2 Systematical consideration of action alternatives

One Training Element need to be dedicated to a resilient mindset and decision making based on systematical review of action alternatives to respond to demands.

Hollnagels four cornerstones for resilience:
- to monitor,
- to anticipate,
- to respond and
- to learn

deliver a framework for an action perspective. In relation to the CSF/REL model that is aimed at deploying resources needed to cope with demands, relevant elements of a cognitive process that are crucial for understanding and conducting resilience in action is addressed here.

Table 8 combines the CSF/REL model with the four cornerstones (Hollnagel 2009), summarizing a cognitive flow leading to decision making, and points at relevant mind steps to be learned for systematic resilient thinking and action.

Table 8. Combining CSF/REL topic with four cornerstones

	monitor	anticipate	respond	learn
Risk awareness	Situational awareness	Sense making		
Anticipate		Assess impact solution and upcoming changes		
Attention		Focus on Solution		
Improvise			Decide on response	
Respond			Act	Understand what happened, the consequences and what may happen

This leads to the following decision and response cycle, a generic TE which can be substantiated in many directions, serving different Training Targets.

- Situational awareness: *what do we actually see, is there more?*
- Sense making[47]: *what does it mean, what might happen next?*
- Anticipation: *what are the alternatives?*
- Decision: *what is our choice in terms of resources, competencies, strategies?*
- Monitor effects of decision: *where should our attention be from now?*

This will be reflected in the TORC Gaming format (chapter 4).

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[47] The notion of "sense making" here accommodates both explication, interpretation and sense *making*, depending on actual need. See Figure 8, p28

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3.3.3 Training Formats

The TORC project has explored several types of training formats while industry partners were consulted to set their expectations and restraints. A traditional approach by classical training was out of the question, given our need and choice to learn by doing. Training on the job was no option either. Ideally a simulation of work to experience reality and to provide a variable training context pointed at the potential of technologies like E-learning and possibly 3D virtual reality training. As resilience training is essentially a team exercise, e-learning was regarded unsuitable for TORC, particularly since e-learning does not allow for responding to or intervening in the training activity as it is ongoing.

The fundamental training formats considered are displayed in Figure 17.

Training classical instruction in resilience and its merits.
>> boring; low transfer of training expectations)
- Training materials, theory and exercises (group and individual)
- Mostly instruction by trainer, trainees have a passive role

E-learning in combination with F2F meeting
>> possible, but unlikely concerning the available project resources; fair transfer of training expectations
- Design e-learning environment, theory, exercises, and automatic feedback
- Available hardware and helpdesk facility to provide assistance

Resilience (compliance) game
>> New and motivates trainees. Positive experiences; higher transfer of training expectations
- Gameboard with gameplay roles and game cards (Possible development of resilience job-aid.
- Small card to support resilience behavior at the work site).
- Leaflet with supportive information about resilience subject, with explanation per category.
- Train the trainer *brief*, and to-the-point. Most important aspects and training procedure

Figure 17. Training formats

The TORC project chose to aim at a format supported by serious gaming without the need to go as far as sophisticated software development to simulate real life. The following TORC training development resulted in a mix of classical instruction to introduce the concepts, supported by a straightforward narrative; serious games (e.g. by means of a board game) to familiarize with resilience in practice, explore the aspects in interaction with other team members and relate the concepts to real-life cases. Workshops and group work were envisaged to facilitate discussion about the learning experience and relate it to the specific in-company setting. For each TORC training type, the mix is adjustable to benefit the interest group and company context optimally.

In addition to these didactical considerations industry partners expressed their needs. With regard to learning and development of employees, they expected a number of principles to be taken into account:

1. Use the most appropriate form of learning. For operations, this means experience-based learning.
2. Use content from which a high learning efficiency is expected. This means that the content must relate to the current and future tasks and operational activities of the trainees.
3. Apply learning on the job; learning in connection with the daily operational practice. This type of learning is regarded recognizable, practical, quickly implemented, motivating and cost effective.

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3.4 Conduct training[48]

The main training groups identified are:
1. Field staff
2. Management
3. Integrated session with both for dialogue.

In the TORC development project, the training and piloting was moderated by a duo:
1. An experienced trainer capable to deal with innovative concepts
2. An R&D professional observing the process and effectivity of training elements/accessories and assisting the trainer.

In preparing the training program several steps were followed:
1. Experimenting with table tops at TNO
2. Conducting a mock up with a trainer and research assistant at the site of the industry partner
3. Conducting pilot with a trainer and research assistant at the site of the industry partner
4. Preparing training by company trainers by a "train the trainer" approach.

The pilot training was provided by the research partners, but in specific cases company trainers were invited to experience their training capabilities in the context of the TORC training and experiment with their possible future role as TORC trainer.

An illustration of a training timeline during a training session is presented in chapter 4.11, *Illustration of Training Timeline*.

A separate TORC report will document specific set ups and experience with the company pilots.

3.5 Evaluation

When a TORC training program is closed, tests and evaluation are important to check if the solution meets the necessary requirements. Ideally, a training program and its sessions are developed in an iterative manner. This means that the steps or products are presented to stakeholders and that the half-products meet the objectives. Iteration brings the opportunity to steer or choose if there are several alternatives.

Training and instruction in the domain of technical personnel would benefit from a sound methodology to evaluate the training outcomes at the worksite. Therefore a transfer of training evaluation methodology could fit in to assess training outcomes. Important factors are manager's support and feedback, if trainees could perform with the new acquired competences and a focus on the work spot are amongst other important, transfer enablers. Questionnaires are used to assess trainees, instructors and managers experiences. However, in some cases this method is not applicable. The most important barrier is the available project time after training. If there is less time between the training and implementation at the worksite, a more general assessment of training effectiveness is necessary.

Before the trainings starts a sound set of criteria must be defined by experts in consultation with stakeholders. Based on the expert criteria, management, and professionals must be interviewed about their experiences with the newly acquired competences. Comparison with the old situation, good and bad work behavior examples and general feedback about the training program is gathered. This next best option

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[48] The TORC game used in the training referred to here, is described in chapter 4

acquires information about training effectiveness on the first, and generally the third level of Kirkpatrick's (2004) typology*: reaction level* and *work behavior*.

Figure 18. Kirkpatrick's four levels, edited.

The following comments may be added to Kirkpatrick's model (Figure 18):

(1) trainee reactions: the degree to which participants liked training, believed it would help them with their job

(2) trainee learning: the degree to which training content was acquired by the trainees,

(3) behavior on the job: the degree to which learned behaviors are transferred to the job

(4) results: the degree to which teamwork behaviors enacted on the job produce safety/quality.

Sometimes a 5th level is used: the Return on Investment: what were the training costs and effort, what are the organizational (financial) benefits.

Guidelines on evaluation of TORC training are elaborated in a separate report published by TNO.

4 The TORC *Training by Gaming* format

Serious gaming is considered as the most suitable training instrument. A dedicated TORC Board Game has been developed to operationalize and support TORC training in an effective and flexible manner. The TORC Game is designed to meet industrial needs and requirements, including the overall aim of supporting the capability concept. According to the actual needs of the industrial partners involved, a prioritized subset of Training Targets (TT) was chosen. This selection guided the actual selection of Training Elements (TE) in focus as well as the practical limitation of the variation of resilience, but the full TORC scope of operational, managerial and integrated training was addressed in the game design and tested in a "normal operation" context. According to the needs of the piloting industrial partners, emphasis was put the ability mimic "real world surprise", a layout that support systematic decision making as well as after-action review, and follow-up of key findings from the training process.

The game is designed to manage capabilities by highlighting both resources and strategies in the game design, and various sacrificing aspects in the decision making process are operationalized as fiches. The TORC game supports various layers of participation; direct participation (players), observation and feedback, as well as reviewing and reflecting on logged results.

A key experience with the TORC game is that some key Training Targets actually may be directly conveyed by the game design.

Details are described in the following, including a suggested playing timeline and pre-training introduction material.

4.1 Training Targets supporting Capabilities

The TORC game is founded on the TORC working definition of a resilient capability:
A resilience capability is the ability to perform or achieve certain actions or outcomes through a set of controllable and measurable faculties, features, functions, processes, or services and encompasses:

- *Competences,*
- *resources and*
- *a strategy*

to enable a sustainable adaptive response to demands due to e.g. disturbances, disruptions and change. A capability can be found at individual, team and organizational levels.

A capability or a combination of capabilities is aimed to have field staff and management prepared for a service or delivery process to respond e.g. to the client requirement.

During the TORC development process and through interactive session with industry partners it became clear that is it was necessary to focus on a subset of targets.

The overarching objectives were:

- To learn what space of maneuver is available for field staff when coping with variation and disturbances
- To elicit informal and formal ways of individual and team decision making in coping with sudden operational demands

- To learn what strategies and resources a company has available
- To highlight and open dialogue on tensions between resilient behavior and compliance boundaries
- To train to liaise with relevant decision makers and supporting staff

The targets were therefore redefined as:

- Experience resilience in action by simulated practices in real company cases
- Learn about resilience as an operational capability to cope with sudden or unexpected demands in work
- Explore and decide on strategies to work with unexpected situations in the operation
- Explore and decide on resources to be deployed to support and back up your adaptive action
- Experience how your team and company network is of great value to support resilience activities
- Reflect on applied capabilities and review on experience build up as well as positive and negative outcomes.

The next step was to explore which existing and new Training Elements were available and necessary to form a Training Strategy for pilot trainings. The following decisions were made:

1. Both field staff and management need to be trained
2. The central element of the training is a serious game
3. It is essential to experience modes of resilience that are available and what consequences of shifting competence envelopes will imply
4. During the training the following aspects needed to be trained:
   a. cope with surprise dealing with real life situations
   b. become aware of the need for systematic decision making based on the four cornerstones of resilience (Hollnagel 2009) and naturalistic decision making
   c. consult and deploy resources available at individual, team and organizational level.
   d. reflect on actions during the job and after the job
5. The after action reviews within the training itself (per definition the spinoff of the integrated training session) is expected to deliver issues to be followed up.

4.2 Selected Training Strategy and Targets

The development of the TORC *Training by Gaming* Format is primarily founded on the development of the Training Strategy of TNO while engaging with industrial partners NAM, Infraspeed and Strukton Rail. The industrial partners stressed the need to train resilience capabilities in operations involving both field staff and management, and complement it with organizational learning.

The selected Training Targets are listed in Table 9 below.

Table 9. Selected Training Targets selected for training development

TT-ID	Training Target	Selection for developing training format
A.	Ensuring sensitivity to the WasI/WasD gap	yes
B.	Ensuring sensitivity to "decisive moments", demands that spark explication, interpretation and sensemaking	yes
C.	Ensuring ability to display "adaptive intention" to surroundings and co-workers	yes
D.	Ensuring sensitivity to adaptive traps	no
E.	Framing of local/situated "rudimentary resilience"	no
F.	Ensuring the ability to deal with the changing imperatives of increasing CvR ratio	no
G.	Ensuring the ability to deal with non-linear development of "graded[49]" resilience	yes
H.	Ensuring the ability to attend to (dynamic) divide implied by the Law of Stretched systems.	yes
I.	Ensuring field staff support to provide feedback about a resilience experience at the sharp end	yes
J.	Ensuring the ability to signal necessary adaptations at organizational level to analyze feedback through after action review.	Yes

4.3   Dimensions chosen for the Training Format

These dimensions were seen as crucial:

1. Fieldstaff-management interaction
2. Experience of resilience in action followed by reflection on action (after action review)
3. Simulating real life experience as close as possible
4. Experiencing all aspects of a resilience capability; strategies and deployment of resources
5. Training of specific competences was anticipated as too ambitious in the contexts and available time slots for training pilots with the participating partners. Skills, knowledge and attitude elicited during the training might be discussed and evaluated but not targeted since this would lead to too limited scoping of the training
6. Need to elicit the gap between informal and formal (rational façade) practices during resilience in action and discuss the impact of working beyond boundaries defined by rules.
7. Need to use serious gaming allowing to introduce experience of resilience dynamics

4.4   Allocating capabilities of target groups specific to targets

With an eye to optimizing training for field staff and management, a first analysis was made to indicate which abilities are specific but not exclusive for each target group. Table 10 presents an overview of relevant abilities to be addressed.

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[49] "Grade" may sound hierarchical but can be a continuous scale.

Table 10. Resilience capabilities allocated to Training Targets and Elements

ID	Resilience capability Training Targets	Ability (Training Element)	Training format
A	Awareness of gaps between planning and operational demands	Creating visibility of gaps	FS Game
B	Sensitivity to changing operational situation	Alertness to small signals and boundaries	FS Game
C	Ability to adapt work strategy and preparing alternatives in consultation with co-workers & management	Coping strategies for adaptation as a team	FS Game
D	Preparedness for unwanted outcomes of adaptations and anticipating potential crossing of safety boundaries	Recognizing and responding to drift and resonance	FS Game
E	Understanding the need for and providing mandate for space of maneuver addressing competences in individuals/teams/orgs	Facilitating conditioned permeability of regulatory boundaries	Mgt game
F	Awareness of resilience capabilities, facilitating the potential to adapt work practices, and recognize those which may lead to changes to the active practice	Demonstrating receptiveness to adaptation and evolving practices	Mgt game
G	Awareness of the mix of resilience grades and ability to deploy and manage resilience dynamically as per situational needs	Smoothly switching between resilience grades considering needs and ability	Int game
H	Recognize and understand the space of maneuver where permitted adaptive behavior is mandated and define the safe operational envelope	Understanding where conditions allow for (more) adaptation.	Int Game
I	Reflecting on adaptive practices provoking dilemmas encountered at the sharp end, capturing tactics for a resilience repertoire	Supporting/helping management approach. Rewarding…	Mgt game
J	Learning from adaptive practices and recognize which need org. change	Anchor experience in personal and org. development	Int game

4.5   Serious gaming

Based on the assessment of different training formats, the serious game was selected as the most suitable training instrument. Based on several experiences with serious gaming by TNO, a board game was considered from the outset of the development to be a hypothetical solution. The main advantages are that:

- people will be brought together in an interactive play and experience group dynamics
- several realities can be designed into the game
- the board game would not cost unfeasible investment in game development
- communication and liaising with colleagues will be stimulated
- every training room can be used
- it is easily scalable and portable into different languages and industrial domains.

One disadvantage is that a board game can accommodate a limited amount of players (here: max 8 people). This can be overcome by adding a *second playing field*, namely to create an observer perspective allowing additional players becoming part of the game. The observer role acts as a monitor of dynamics during the game, and may deliver crucial input for the after action review during the game. This solution would allow for training groups of 6-10 trainees.

The serious game is assumed to be part of a multiple-method learning session scenario:

1. After an introduction, sessions begin with a board game placing each team member in a specific role relevant to the case. A number of typical resilience cases are 'played' in a real life setting
2. This is followed up by intermediate feedback
3. Finally, employees reconvene to hear feedback and report on what they have learnt
4. Follow-up coaching is provided as reinforcement

The intention of the board game is finally set to make the teams aware of the appearance of resilience, in which surprise is tangible, irregularity is normal, and someone steps in the breach to fix it. It introduces the concept of graceful extensibility, and the appearance of decomposition (inability to respond), creating a real-life experience as a basis for introduction of the R1-R4 scale (see Table 1).

4.6 Resilience modes to be explored

There are various ways in which organizations can deal with surprises in their operations. Based on the theory of Woods (2015), 4 modes of resilience (see Table 1) were taken as a basis to explore what resilience implies and how formal (e.g. rules, SOPs) and perceived boundaries (group norms and culture) might be challenged.

Taking this theoretical framework as a key principle, a transfer was needed towards real life work and the scale of transgressing existing boundaries by virtue of anticipation, in a manner that will be understood by field staff and management and experienced by them in every day operations (Table 11).

Table 11. Levels of anticipation embedded in resilience levels

Mode		Level of anticipation to surprise	
R1	Defend	The operations system as modeled is sufficient. Deal with surprise as it comes.	Acting allowed only within system boundaries.
R2	Build	Make the modeled operation more robust at the points where known potential disturbances will impact. Do not allow actions outside of system boundaries.	Add robustness to the system. Acting allowed only within system boundaries.
R3	Stretch	Provide the option to cross operational system boundaries (and rebound) when dealing with an unanticipated disturbance.	On a case-by-case basis, allow acting outside of the system it does not work for a situation.
R4	Sustain	Continuously provide the option to cross system boundaries if required in dealing with operational disturbances.	Continuously provide the option to act outside of the system if the system does not work for a situation.

Hence, complementary to the compliance regime with its defensive systems to respond to impacts, a resilient organization may allow minor supplementary adjustments to increase effectiveness of the defensive systems (R1), or aim to anticipate specific operational disturbances and make the operation more robust at the spots where the disturbance will occur (R2). Beyond that, the organization may decide that it also wants to anticipate on disturbances which are not yet known and allow the operation to enter the unknown territory by moving outside of the system boundaries on a case by case basis (R3). Ultimately, the organization may decide that it regards resilient acting as an organizational function and continuously provide the option to cross system boundaries when the system does not work for the situation at hand (R4). Depending on the nature of the operation, the organization can adjust the different modes of resilience to the requirement of its operation and vary the modes depending on the operation at hand.

R1. Defend normally (preferred mode of operation); work conforms to standard operating procedures (SOPs), allowing only minor supplementary adjustments and variations

R2. Build robustness to anticipated disturbance; resist change to well-known disruptions without adapting the systems initial stable configuration (response mostly solidified in SOPs, plans)

R3. Stretch and rebound in an (isolated) surprising situation/episode; change current way of working to handle different, other variations outside the well modelled operational situations (cascading events, frictions between SOPs and time available, de-synchronization of tempo at different organizational unites, roles and levels)

R4. Sustain resilient functioning over time; handle different episodes of unexpected situations over time with multiple goals that must be controlled by multiple actors at different (multi-) organizational levels

As aspirations increase from R1 to R4, this scale thus commences from a comparatively simple notion of a well-defined and confined response based on a specific (safety) protocol or heuristic, or even a predefined or learned strategy. At the other end, resilient functioning may take the form of a more boundless intra- or inter-organizational mobilization; as an ultimately *emergent* response to a *novel* challenge or demand.

The TORC Game Training Format accommodate this by defining zones symbolizing those resilience modes. The concept is to explore and exploit different levels for resilient functioning by moving through various zones in consecutive steps during the game. By doing so several competence envelopes will need to be addressed. When plotted on a time line the training will form a trajectory or pathway of adaptive episodes through the zones, while coping with unexpected operational situations.
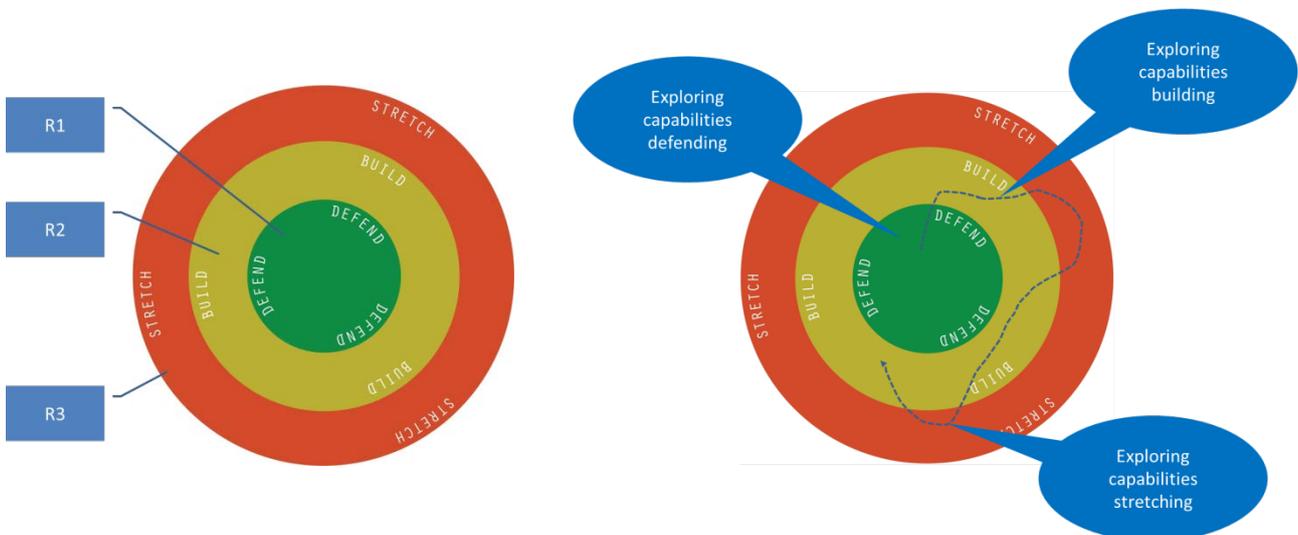
Figure 19. Training Format for resilience modes

Building on this concept of shifting competence envelopes and resilience "forms" R1-R4 (see Table 11), the domains R1-R3 were selected for inclusion in the training set up. The main reasons for this omitting R4 are:

1. Industry partners do not (at the time) have a compliance and/or resilience strategy to act without rules or go beyond rule to get engaged in sustainable resilience[50].
2. The development of capabilities with the industry partner requires a stepwise and feasible approach keeping the training close to present operational practices. Since the privileged position of

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[50] One exception may however be disastrous calamity which need a complex set of adaptations and shifting governance.

compliance is grounded by law, contract or company rules, it is assumed that exploring the R4 domain overly ambitious. It may therefore blur important aspects of actual training[51].

4.7 How to capture and manage resilience of adaptive paths

Resilience is an emergent quality but needs to be guided by a conscious mental process dealing with the four cornerstones of resilience and following a sound decision making process starting with alertness, situational awareness and sensitivity to risk.

The TORC Gaming Format accommodate this mental process the following steps, supporting them to prepare an appropriate resilience response:

- Situational awareness
- Sensemaking
- Assessing
- Analyzing and projecting
- Deciding
- In-action review (ongoing reflection and information exchange during the job)
- After-action review (reflection after the job has been done).

Table 12 relates these mental steps to Training Targets defined earlier and translates them to everyday practices.

Table 12. Understanding and responding through mental phases in relation to training types

	Field staff (operations)	Integrated	Management
Situational awareness (MONITOR) TT: A, H,	Understand what you are looking at. Know what to look for Be aware you got all it needs (competence, tools, information, etc.)? Think it over: is anything out of the ordinary that may start misbehaving?	Enrich understanding of situations by sharing observations and discussing what is planned with peers and co-workers as a natural part of the work.	Understand how a situation sits in the bigger picture. Understand how a situation moves under the influence of variations in the interfaces. Scan variations e.g. planned work, changed scope, scale or capacity of the operation, for possible knock-on effects
Sensemaking (LEARN) TT: B	What is the story now? And now what? If a variation that looks normal turns out not normal, how might it impact? What will it look like if you take an action	Interlink functions 'Unfiltered' communication (team and network, bottom up and top down) to interpret the flow of experiences into words and categories as a springboard for action	No blame Listen through different channels Look from perspectives unavailable at the sharp end
Assessing (UNDERSTAND)	Consider success/fail options (and cascades)	Discuss event horizon – prognosis on what might happen next	What do you need? Mandate space of maneuver. Defer to

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[51] It is however easy to expand with R4 at a later stage

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	Field staff (operations)	Integrated	Management
TT: E, G	Defer to expertise	And now what?	expertise
Analyzing/ projecting (ANTICIPATE) TT: C, D	Deal with dilemmas: What to expect. Who do I need to talk to before my next step?	Project consequences of a decision in the future	Deal with dilemmas: what is the intention of the rule, if this intention is still achieved, how? (by means of which actions or precautions), if it is not, what are the risks / impacts
Deciding (SELECT)	Draw your conclusion on which actions to initiate: Who needs to know about it?	Is there a good balance between resilience and compliance?	Does the team have sufficient room for maneuver? May non-compliance be a responsible alternative?
In-action review (TAKE PULSE, MONITOR EFFECTS)	Monitoring effects of adapted way of working: Where are we going, What are effects of our response? Do I have the same understanding of development as team members Is the response effective enough?		Are adaptations backed up by the four-eyes principle What new lines of defense are considered?
After action review (EVALUATE) TT: F, I, J	What is our experience, what are tacit and explicit assumptions and decision? What are the positives? What are implicit and explicit assumptions? Have adaptations been executed in controlled way?		Is our resilience strategy adequate for work as done? Was the gap between work as we imagined and work as done closed?

Hence, the Training Format guide trainees through a systematic and cyclic decision making process. By making this process explicit and to engage the other trainees in this decision making, a dialogue is set up. Based on a mental map of how to cope, a demand will then become subject of peer review and exchanges of experiences and perspectives. The format aims at thinking by talking aloud and invites trainees to engage in exchanging ideas, assumptions and knowledge in order to co-create a solution and prepare a resilient response.

The phases mentioned in Table 12 is condensed to 5 steps:

- Situational awareness
- Sensemaking
- Anticipating
- Deciding
- Monitoring effects decision (in action review)

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This circle is complemented with a complementary cycle of after action review. Preparing the evaluation of the talks by individual trainees in a later stage of the serious game.
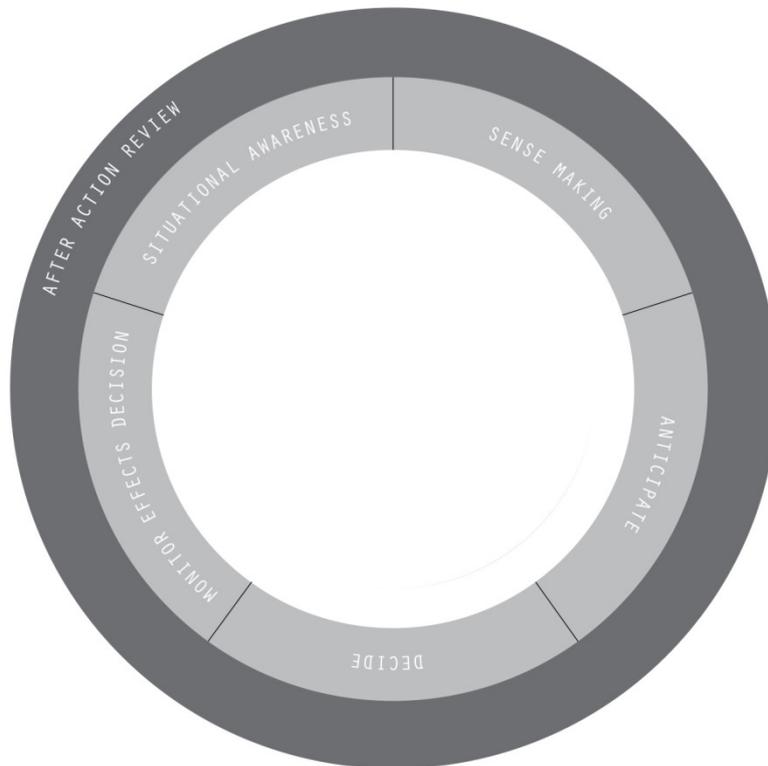
Figure 20. Mental map of decision making process to prepare resilience response

4.8 Managing capabilities

A field-staff team needing to organize a resilient response need to have methods and resources or the capability in practical terms to have their mission completed safely. Given our definition of resilience capability this requires dealing with strategies and resources to deliver the response.

The Training Format seek to

- bring participants in a play that allows them to experience their capabilities in the simulation of their work. This creates a virtual arena to apply different strategies to work safely but also being able to complete their work efficiently under various operational conditions.
- make participants aware that they have resources at their disposal and the need to organize and deploy them in order to form and create a resilient response.

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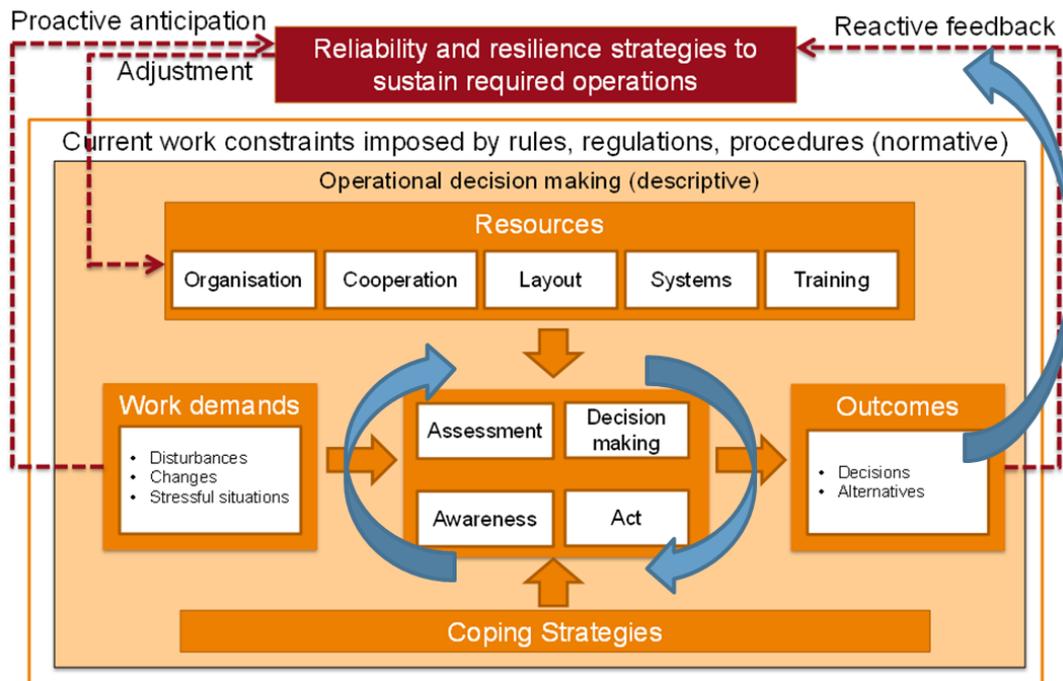
Figure 21 Strategies to guide decision making in resilience dynamics (source: TNO)

The use of strategies in the serious game setting aims to increase operational resilience of the team and the organization as a whole. This in turn may result in better production, and may ultimately reduce costs.

In addition to the various operational conditions, the serious game needs to address that different operational targets are part of everyday work to everyone (e.g. compliance, safety, efficiency) as well. Is it necessary in dealing with dilemmas that all operational targets must be met to the full degree?

The Training Format aim to learn to organize a balanced resilience response by choosing:

1. an appropriate strategy
2. organizing necessary resources to implement decision
3. balancing trade-offs of benefits and costs of a chosen strategy or combination of strategies.

A resilient capability must be manifest first and foremost at the operational level. Specifically, concerning managerial *decision support*, *robustness* in operation, *resourcefulness* and *rapidity*, the CSF/REL model (Figure 14) can be applied to visualize the managerial contribution to the actual capability.
The "contextual engagement" from the managerial side in terms of defining and tuning the "modality" of the anomalizing process at the operational level (Figure 8, page 26) can be associated with (CSFs) *risk understanding*, *anticipation* and *attention*.

Research was done to illuminate what key concepts and issues that need to be integrated in the training format. The TORC Training Format needs to balance transfer of knowledge (what are useful strategies and resources) and learning to apply them in a context of group dynamics of field staff.
The following paragraphs discuss the selection of strategies, resources and trade-offs to be chosen.

4.8.1 Strategies

Resilience Strategies are the methods to mobilize the resilient inventory (the resilience resources) into an operational capability, e.g. in terms of adaptive clusters. An optimized utilization of the inventory (resources) can be done by (re)designing, e.g., resilience oriented human-system interaction or crew composition; by providing resilience oriented operational tools and procedures, resilience oriented trainings for individuals (coping with stress), teams (team dimensional training) or organizational campaigns, etc. Example outcomes of applying these strategies will be, at an individual level: being well rested, knowledgeable, timely, able to cope with stress, etc. At the team level, examples are supporting behavior and mutual understanding. At the organization level: trust; financial buffers.

Based on additional literature research several strategies, heuristics, patterns tactics, and practices to support developing resilience were taken as a source for selecting a set of strategies for TORC. Several subsets are discussed in Annex 2 *Resilience strategies and tactics (patterns, heuristics) (to transform "resilient inventories" into "resilience capabilities"*

The strategies and tactics selected were used to build the abilities to respond, monitor, anticipate, and learn in high cyclical load situations. They could be applied to other situations as well, such as responding to emergent issues in maritime contexts. In order to structure our findings we decided to use the framework described by Lay, Branlat & Woods (2015). The practices mentioned vary in scale. Some apply at the level of the individual or team, while others apply to the (operational) project level, and others apply across the organization. The TORC selection started from this source:

1. Manage deployed resources
2. Provision of extra resources
3. Manage priorities
4. Support processes of sense making
5. Support reflective processes
6. Anticipate resource gaps and needs
7. Anticipate knowledge gaps and needs
8. Use questions to trigger learning.

During discussion with industry partners and further exploring the strategy concept, finally 10 strategies were selected to be used in the serious game:

1. Adapt work process
2. Add (human) resources
3. Manage priorities
4. Make sense of developments
5. Support active reflection on developments
6. Reallocate resources
7. Acknowledge viewpoints team members
8. Learn in action and share information
9. Appoint leading person in team
10. Create liaison for decision support.

4.8.2 Resources

Resources are the means allowing a team to organize itself for a resilience response. The relevant resources were selected in consultation with industry partners:

1. Information
2. People
3. Assets
4. Time
5. Communication lines.

4.8.3 Sacrificing decision making

Not all targets of a team can be fully met. Balancing budget, time slots necessary and resources to deploy are inherent parts of the discussions that employees need to conduct before reaching a decision on a resilience response. In order to approach real life deliberations when opting for a response, every resilience response come with a "price".

With an eye on the drift into failure model three kinds of "investments" were selected to be taken account of during decision making:

1. The extra mental load resulting from alternative action and additional task when responding
2. The safety balance: how the risk will change as a result of resilience activity. Are risk transfer or new risks raised although resilience take place in a controlled way?
3. The gain or loss of efficiency in preparing and deploying the resilience response, e.g., loss of time , costs of additional resources needed.

The Training Format allows players to experience these dilemmas, as they are challenged to make sacrificing decisions. They need to learn to choose different strategies to overcome challenging operational conditions, anticipating necessary "investments".

The solution chosen for the Training Format was to introduce an element at the moment of decision making (a phase of the aforementioned mental map), namely the consideration of an appropriate strategy and choice of resources (or combinations). In order to introduce a starting point for this dialogue an overview of strategies and resources could be provided. By doing so the training has a facility to present knowledge on possible strategies and resources. Experience and knowledge both from theory and from company experience can be introduced and transferred to the trainees.

The TORC training was prepared with an idea to deliver an overview that trainees may consult during the training. The selection of strategies and resources on the one side and weighting the necessary "investments" should ideally be developed as a separate Training Element with its own training format.

4.9 Serious gaming of resilience in action

The TORC gaming format will accordingly have to:

1. Allow to simulate company cases
2. Trigger unexpected situations and events
3. Give trainees the opportunity that resilience require social interaction to cope with demands
4. Address several levels of resilience preferably individual, teem and organizational resilience.
5. Create a vivid interplay that triggers tacit knowledge and experience and creativity
6. Be interesting and challenging to keep the game running and energize participants

7. Be realistic and create a connection between the training and real world.
8. Create a safe gaming climate to explore boundaries of real and experience compliance restricting resilient response
9. Be applied in training rooms of companies to be as close to everyday operations as possible. In theory even being facilitating to play in a room on a plant site.

It was hypothesized that this would be achieved by:

1. Having the game played by a team of people
2. To have them working on real company cases with an incident case or a positive resilience case
3. To introduce game changers that divert the players in a step by step manner, guiding them to explore new demands and challenging adaptions in a continuous flow of events

From this point of departure, a serious game was developed. The starting point for the game is a normal activity case to introduce resilience as an adaptive capacity, say, the R1 mode. The game can be designed and played in such a way that it progresses towards emergent cases due to "surprises" in the play in order to possibly arrive at the most difficult mode R3. The REL-model (Grøtan, 2011), see Figure 14, can be applied as a resource to navigate through adaptive episodes/clusters/formations. At R1, the explication and use of predefined resilience strategies is encouraged (corresponding to the "explication modality"[52]). In the more demanding fashion (R2 and R3), the resilience strategy must be chosen from a set of options ("interpretation modality"[53]) or actually "created" on the spot ("sense-making modality"[54]). For more details, see Annex 2 Resilience strategies and tactics (patterns, heuristics) (to transform "resilient inventories" into "resilience capabilities".

However, TORC training must also encompass managerial contribution to resilient capabilities. This was devised as an optional strategy to seek/offer decision support.

For the purpose of the integrated training, the emphasis in the serious game is on team resilience with multilevel resources and demands connecting bottom-up and top down (Figure 9). Hence, management and operations work together in a team to jointly deal with the dilemmas. Horizontal trade-offs (between operational options), vertical trade-offs (across organizational levels) and cross-boundary trade-offs (across the boundary of the domain) are common in day-to-day reality and all require an end-goal perspective, where they compete with other pressures and interdependencies. A TORC capability represents the capacity to respond, through interaction and mobilization (of abilities), across individuals, teams and organizational boundaries.

This choice for this format implies a playing field of 6-8 players around a game set up combining:

1. A trainer being the game leader possibly assisted by someone observing the group dynamics and assisting with practical issues. This assistant may be someone to be trained as trainer.
2. A playing field for experience competence envelopes and resilience modes
3. A playing field to experiences mental step for resilience response
4. A playing field for after action review
5. Space for 8 players

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[52] See Figure 8
[53] See Figure 8
[54] See Figure 8. Note that the label "sensemaking" on the game board (Figure 22, p72) conveys all three "modalities" mentioned here.
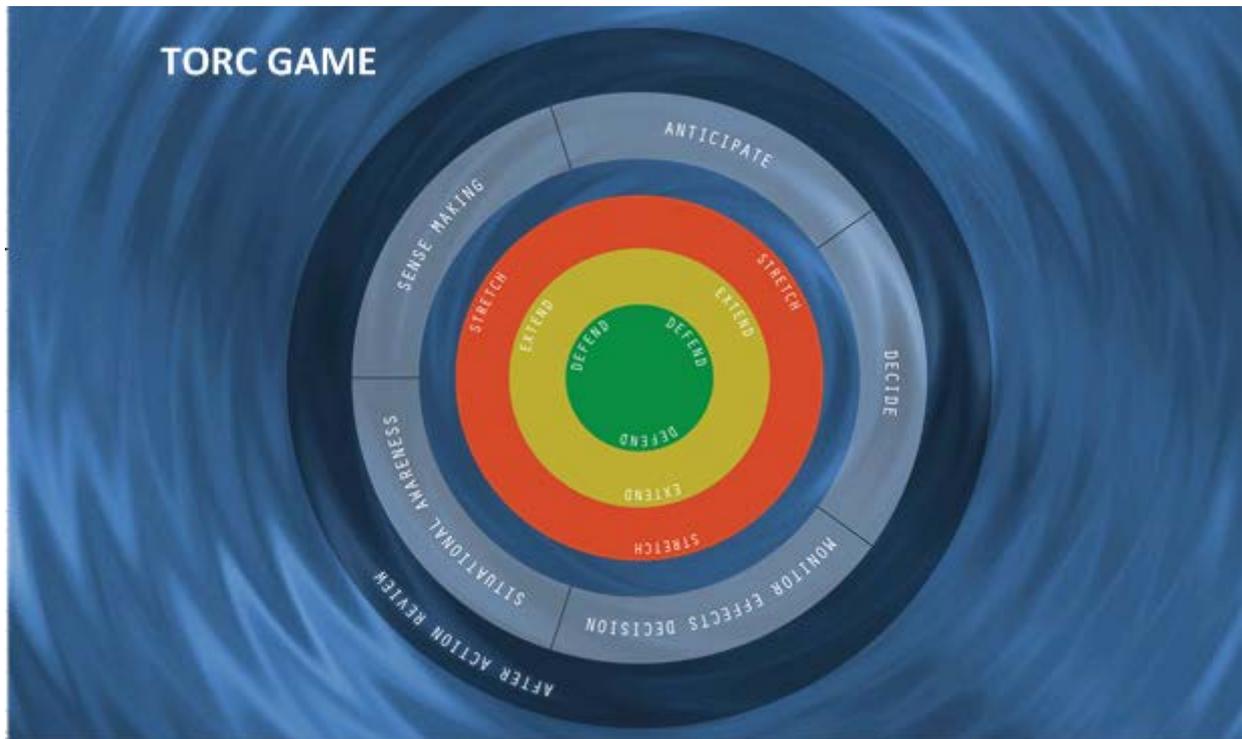
Figure 22. TORC game board

This board accommodates gaming elements to be added in a later stage.

To provide a set up for resilience simulation and response the following formats were chosen:
1. Each play will be split up in 6-8 turns
2. All players work together in a team to use team resources and "the wisdom of the team"
3. One team member is the leader of the turn
4. Each turn is allowed to take a limited time span in order to created time pressure and keep the flow in the game
5. Starting with a company case, each turn will be a moment for introducing a new demand by using game changer cards (derived from realistic company cases and a repository being created by the TORC team)
6. Once a response is decided upon the turn will go to a next player.

Based on this format and design the TORC general Training Format will be applicable by having the game being repeated amongst field staff, management and both together. This will depend on the Training Strategy chosen.

One specific way was chosen as the "standard" to play first with field staff and later with management, employing the same use cases. Both trainings then become the basis and input for and integrated training. Integrated training is thus not specifically a third game per se, but an after action review of the individual game and simulations. This constellation allows:

1. Exchange of experience
2. Comparison of strategies, resources used
3. Encounters with dilemmas

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4. Elicitation of gaps between work as done (field staff perspective) and work as imagined (management perspective)
5. Moderation of the a dialogue by the trainer to facilitate both groups to explore experiences and visions on resilience in action
6. Agreement on follow up and even specific actions to be planned.
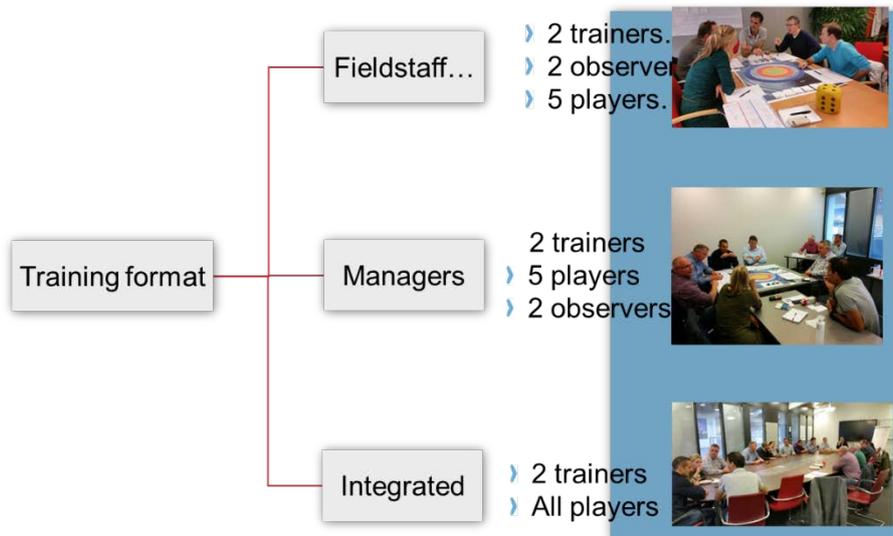
Figure 23. Foundation of TORC training format, a triple of related sessions

4.9.1 Field staff in focus

The main objective for *operational training* is to experience and articulate the necessary 'margin of manoeuver' in terms of R1-R3 scale, in a way that engages and triggers workers to exploit or explore different resilience strategies and to consider relevant resources.

4.9.2 Management in focus

The main objective for *managerial training* is to assess, articulate and communicate the mandated space of manoeuver in terms of R1-R3 scale, in a way this establishes a sound balance between the validated and anticipated operational capabilities, and the surrounding technical safety and risk picture.

4.9.3 Integration and dialogue in focus

The main objective for *integrated training* is to ensure that the chosen reconciliation of margin versus space of manoeuver is founded on a proper balance[55] between the 'work as imagined' (WAI) and 'work as done' (WAD). Comparing the game results of both organizational levels (operational & managerial) gives input to develop viable options for more adaptive plans and strategies to be sufficiently adaptive and resilient as challenges change over time. For each problem/ scenario or each objective a company can create an adaptive plan (in situ) which can comprise different resilience strategies and map out the consequences in terms of resources (time, money and people) and targets (compliance, safety, efficiency). The options that arise from this process can be captured in an adaptive plan.

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[55] Total alignment between WAI and WAD is not necessarily the issue here. Quite the contrary, a residual "imbalance" may be attributed to justifiable pragmatic differences. Ultimately, such differences may even be seen as sources of fruitful dialectics in the future

This alignment process can also be represented as in Figure 24 (borrowed from David Woods).
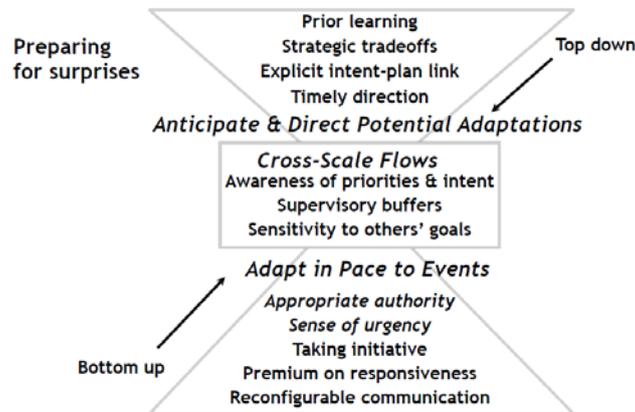
Figure 24. Field staff and management both need to engage in resilience dynamics (source: David Woods)

After a brief introduction of the concepts, the serious game is introduced. By means of a real-life industry case presented at the start, the game creates an instant connection to the team's day-to-day realities. Cards corresponding to a resilience mode will help the teams navigate through the decision-making process in a resilience/compliance setting. Throwing the dice brings in elements of uncertainty or severity and rewards can be lost or won. The questions and instructions on the cards help the team analyze the case and apply resilience strategies.

4.10 After action review

The chosen format of the serious game will also facilitate a complementary format to train resilience in and after action, engaging trainees in reflection on tacit and explicit behavior, thinking and considerations. The format facilitates the following:

1. Having the players being observed by other trainees (allowing for an extended training group of 8-10 people)
2. Introducing an explicit team review process reflecting the play directly on a content level (reflecting the story telling in Figure 25)
3. Recording the findings during one or more serious games either by field staff and management (reflecting the after action review and transfer to learning organization in Figure 25)

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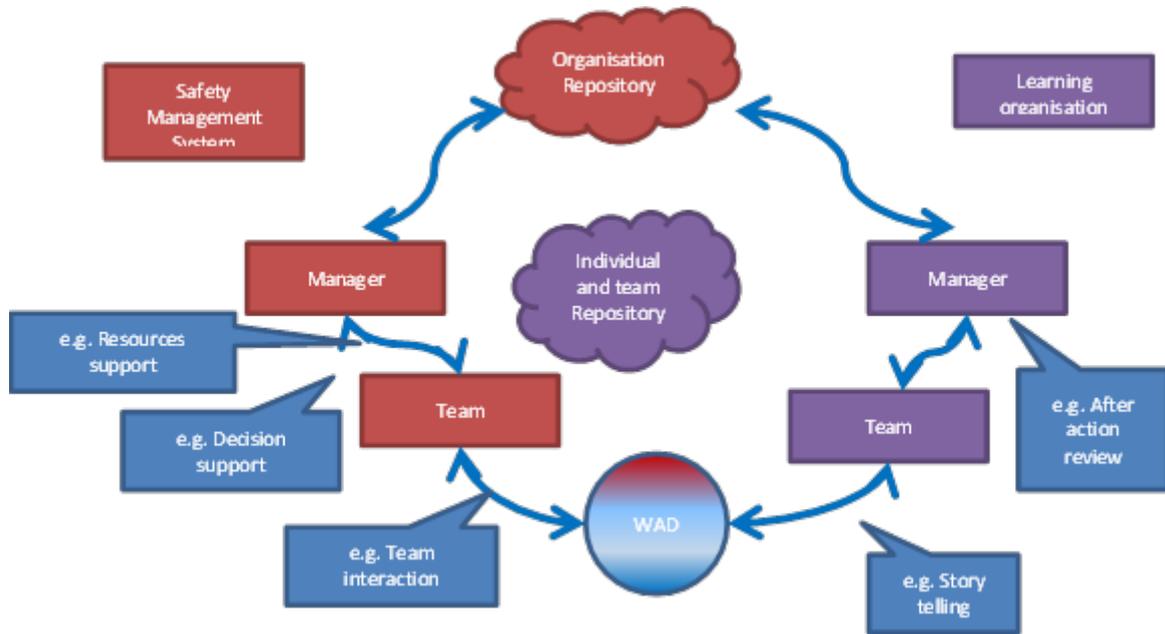
Figure 25. Resilience in and after action in the context of a compliant organization

4.10.1 Review by observers

The observer role enable someone to observe the team behavior on content and process level, and give feedback on that.

In the development of the TORC game, their contribution was structured by a specific instruction with respect to their role and by providing an observation form.

Figure 26. Typical training set up: playing table and observer table

4.10.2 Review by players

The players are asked to reflect on their decision, stepping back from their group dynamics during the play itself. To assist this reflection, an additional element was introduced by having the leading player making explicit his/her choice for particular strategies, resources and decision and project them on a log poster (Figure 27). By this log poster it is possible to record:

1. The strategies, resources and decisions
2. Notes of reflections
3. Resilience mode experienced (Build, Defend, Stretch mode)
4. Costs or investment considered when proposing a specific resilience response (extra mental load, shift in safety level and efficiency).

This log poster is aimed to be used in every training session.
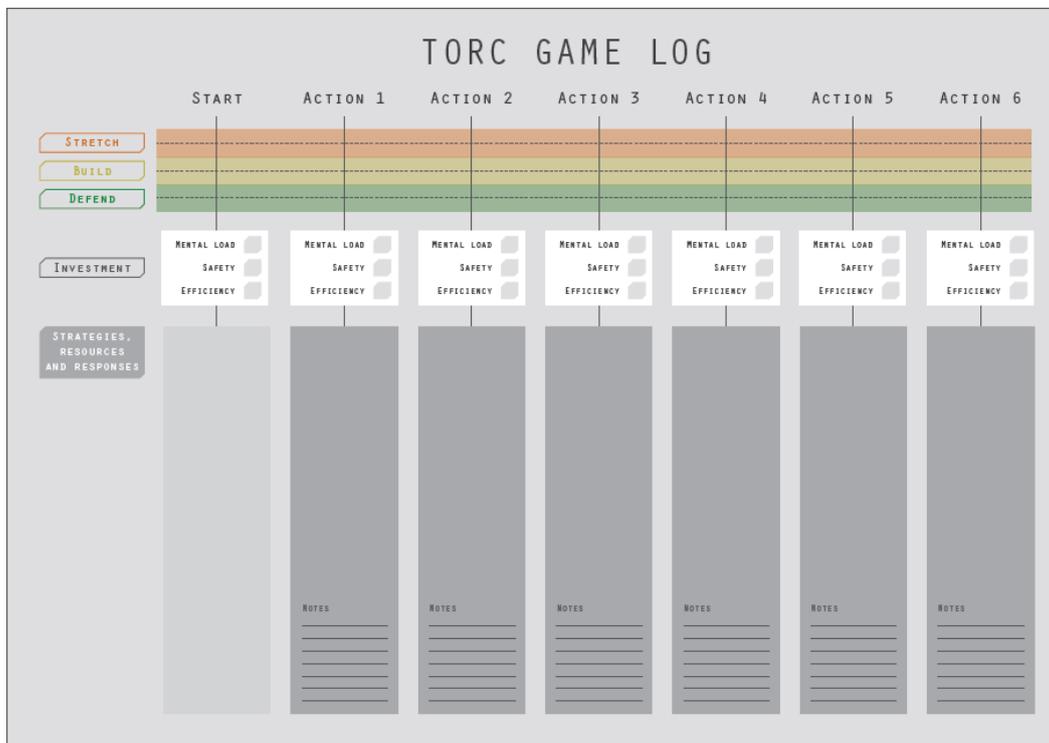
Figure 27. TORC Log poster to support after action review during and between training sessions

4.10.3 Review by field staff and management in integrated training session

The integrated session is the "meeting place" for reviewing the dynamics and findings by individual field staff and management sessions. It creates an arena that allows reporting on specific perspectives, moderation of resilience vs compliance reconciliations experienced in the game, and later on to be practiced in everyday operations. The log poster is a key resource for this.

Typical issues for the integrated training are, e.g.:

1. What is the gap between work as imagined and work as done?
2. What are specific strategies and resources applied, and what does that mean for future operation?
3. What specific operational issues pop up that need to be discussed in more detail and solved in the follow up of the training?
4. What were dilemmas faced when considering a resilience approach?

By recording the relevant issues necessary follow-up of the training can be agreed upon. This will close the loop from resilience in action to resilience after action, feeding the learning organization and preparing management and field staff for future resilient responses.

4.11 Illustration of Training Timeline

The following training timeline may be used:

- Preparing relevant cases
- Preparing relevant strategies, resources and other issues to be considered during the training
- Planning 3 or more training sessions:
  - Expected training time 3-4 hours per training session for field staff and management separately.
    This can be organized as one or more training sessions for field staff and one or more sessions for management.
  - Expected training time 2-3 hours for integrated training session
- Close out meeting by trainers with company.

A related example agenda for training is shown in Table 13 below, and an example of an introduction is shown in Table 14.

Table 13. Example of agenda for field staff training

Agenda for training session
• **Welcome and introduction (20 minutes)**
• **Short explanation about resilience and its relevance for safe and effective operations (max 10 minutes)**
• **Short explanation about the game and the rules of the game (10 minutes)**
• **Introduction scenario case 1 (10 minutes)**
• **Gameplay in max 4-6 turns, probing resilience scenarios (4-6x10 minutes)**
• **Reflection by trainees (10-15 minutes)**
• **Reflection by observers (10-15 minutes)**
• **Introduction scenario case 2 (10 minutes)**
• **Gameplay in max 4-6 turns, probing resilience scenarios (4-6x10 minutes)**
• **AAR 1:Reflection by trainees (10-15 minutes)**
• **AAR 2 Reflection by observers (10-15 minutes)**
• **Reflection of logposters analysis**
• **Evaluation of training process**
• **Identified learning, conclusions and take aways**

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Table 14. Example introduction to the training framework and game structure.

Slide: **Aim & content game**
› Train to conciliate resilience with compliance in operations
› Essentials:
 › Game instruction
 › Game elements
 › Roles
 › Case; start game
 › Evaluation (review)

Slide: **Resilience**
› Work is not always done as though of in advance.
› Resilience is the ability to notice and to recognise changes and to take adaptive action in time. It is something what you do as an organization or as a person before and during your work.
› The challenge is to respond resiliently within the mandate and norms given as a framework in the safety management.
› By talking about experiences within the organization the resilient ability will be strengthened. By learning the organisation from work preparation to execution and evaluation, will build up ability to cope with variations in future. It helps to be prepare to work safer and more efficient under changing circumstances.

Slide: **Coping successfully with variance, disturbances and surprises**
Lack of time
Limited situational awareness
Rules do not help anymore
Improvise/adapt
bad introduction

Slide: **How to deal with disturbances?**
Routine/Defend
› This is the preferred mode of operation. Resilient action takes place to de everyday operational surprises within the boundaries of the normal opera Procedures and work permit suffice for task and situation according to pla
Build/Extend
› Extra defences by means of robustness are added to the normal operatio model at spots where there are known vulnerabilities or procedures need interpreted. Boundaries of team mandate are touched.
Stretch
› On a case-by-case basis, controlled acting outside of the operational mod option when responding to unexpected situations. Work permits, procedu resources (people, transport equipment) provided no longer support nece action.
› Limiting condition: adaptivity controlled

Slide:
Reflection after action
Reflection in action
Shifting competence envelopes

Slide: (diagram only)

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Elements of the game

› **Resilience strategies**: **ways** (method and aim) how you **deploy or use** resources. E.g. the team prioritize by delay certain tasks or to cancel. You may reduce work stress and you create more time to focus on the unexpected situation.

Resources: the organisation/ team has the availability of affluent number **people and assets** to do a job. These are always limited because of available number, time, distance, energy and information/ knowledge at hand.

› **Response**: the **decision you take as team**. The aim is when you need to build (extend) or stretch you keep in control over the situation with the strategy and resources chosen.

The case: the players

› You are the operating team
› The player who has the turn has the role of senior operation technician of the operating team

After action review by:
- Player
- Observer
- Team to field staff group<>management group

AFTER ACTION REVIEW

› By players
› By observers
› By field staff in dialogue with managers (integrated training)
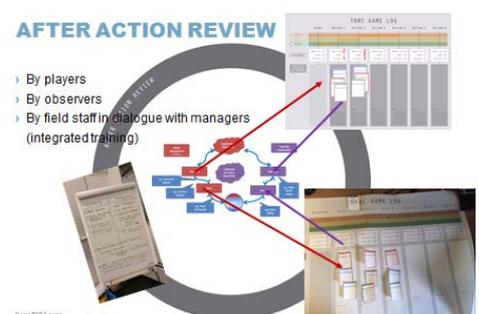
5 Conclusion and guidance for further work

The TORC approach is designed to be applicable in different contexts; in a normal operation context where pre-existing rules and procedures form the expectations of compliance, in an emergency context in which emergency plans from the presumptions of compliance, and in a "managing the unexpected" context in which the applicable set of rules and procedures must be collected and formed instantly and situation-dependently.

The TORC project has chosen serious gaming as the key foundation for innovative training aiming for the objectives and targets described above. A board game has been developed and piloted. The TORC board game has proved to be an excellent sensitization device that supports and fuels operational, managerial and integrated training activities in terms of revelation of existing adaptive practices, exploration of hypothetical situations with close as well as more distant proximity to known practice, and joint reflections and after-action reviews, comprising both homogeneous and heterogeneous training groups.

The practical experiences from piloting the TORC board game in different industrial contexts have, co-creatively, opened new horizons and prospects of safety-relevant organizational training and knowledge development beyond the traditional confines of safety training and management. The practical experiences also confirm the underlying TORC presumptions on 1) the pragmatic value and recognition of the "resilience in context of compliance" premise, and 2) the urge for management to explicitly mandate a "space" of maneuver that legitimates a professional and craftsmanship-based adaptive capacity hallmarking resilience. That is, a "shifting competence envelope" for which also the management side is accountable, that otherwise will have to continue to exist tacitly behind a "rational facade" of compliance, without being credited for its achievements, and with the risk of penalty for non-compliance when adaptations fail.

It might therefore be argued that without the knowledge generated by means of TORC (or other means), management (at some level) might be rendered ignorant about the activity behind the "rational facade". We dare to say that such a situation implies an unnecessary risk.

The actual piloting activities at different industries, including the preparations, are documented in separate documents from the various TORC partners.

6 ANNEXES

Annex 1 is a resource for interviews as part of sensitization, intake and preparation for TORC training.

Annex 2 is a list of prototypical resilience strategies that can be used for local elaboration and adaptation as part of preparing TORC training content.

Annex 1 Semi-structured TORC interview topics

Interview topics:

Risk awareness (Make sure that risk awareness is maintained, avoid underestimation of risk)
1. Risk Assessment
    a. Does one notice that the ("formal") safety boundary is approached (how?)
    b. Boundaries define work roles and interrelationships, and help people to know what they are to do, with whom, and how. Boundaries are therefore enabling, not merely constraining. They signal the existence of a boundary in the operational work flow (serve as informational cues). About what limits are we talking?
        i. Individual safety / risk perception?
        ii. Rules, standards, contracts (laws, procedures, instructions)?
        iii. Norms and values (think of lifesaving rules, we work safely or we do not)?
        iv. Situations where the procedure 'ends'?
        v. Situations where the safety margin is reached?
        vi. Situations when information lacks?
        vii. Situations where local authority and initiative stops?
        viii. Situations where inspections/ checks and supervision are performed?
        ix. Situations where different (conflicting) goals at other (network) levels are present?
2. Understanding: does the team establish common ground/ common mental image of the situation or other decision makers, distributed cognition?
3. Anticipation; drift into failure recognized and addressed?
4. Attention:
    a. To early warnings, changes, safety vs. other goals, simultaneous operations, safe system actuations/ process disturbance control. Early warnings / weak signals provide information about potentially deteriorating safety before this is manifested in usual trends.
    b. Attention to phase transitions (green, amber, red) within TORC framework. How are they recognized (indicators) and handled?

Adaptive Capacity (potential for future action: response to situation when it is <u>not</u> the same as in the past; implementing/ using redundant resources or discarded resources due to FBC)
1. Responding (incl. improvisation – resourcefulness-adaptive performance, exception handling); when do procedures not help anymore? Ability to generate, mobilize and implement resources swiftly and correctly?
2. Action implementation
    a. Existence of "atypical" interactions (across "typical" crosspoints and boundaries)
    b. Flexible organizational structure; are ad hoc collaboration units established to handle situation outside formal communication and cooperation structures?
3. Coping strategies – adaptive behaviors applied in practice
4. Task preparation
5. Information sharing
6. Collaboration/ back-up behavior
7. Communication/ information exchange about situation
8. Decision making - autonomy
9. Training
10. Adequate resource allocation and staffing (incl. Buffer capacity, ICT systems)

Support (Be able to support decisions (remedy of goal-conflicts) in order to maintain critical functions

1. Decision support Management
   a. Top-level commitment: top management demonstrates commitment in addressing problems affecting the performance of people. Is space given to work on the basis of craftsmanship, exhibit adaptive behavior in practice?
   b. Informedness/ Awareness: monitoring based on leading indicators?
   c. Resilient culture
      i. Just: does the organization support reporting issues / incidents through organizational levels up, but does not tolerate culpable act (sanction policies)?
      ii. Learning: does the organization responds to events with recovery actions and real reform rather than denial of problems (learning)?
      iii. Flexible: is the organization able to adapt to new or complex problems in a way that the ability to solve the problem is maximized without disturbing the operation (react)?
   d. Preparedness: is the organization actively responding to problems in (human) performance and preparing for it (anticipation)?
   e. Opacity (trade-off awareness): the organization is aware of economic pressure (budget cuts), workload and pressure on safety and the degree to which they need to make efforts so that related safety barriers are not degraded. Chronic vs. acute goals, efficiency vs. thoroughness, brittleness /resilience vs. optimality - FasterBetterCheaper: where on the line of these hard limits is the organisation? How does management support the handling of trade-off between safety and production?
   f. Availability for support; How do we compensate for degradation to uphold/maintain critical functions? What is the influence of stakeholders on the operation (constraints due to regulations, decisions, contracts, inspections of clients, government agencies, industry organizations)? What is the effect on the operation / management? What does this mean for the latitude of people?
   g. Dilemma handling; How are dilemmas dealt with, and what is the role sharp and blunt end in it?
   h. Stakeholder constraints (Board, Government, etc.): tangled layered network of UABs in sight and managed?
2. Decision support Systems: support staffing, support systems (monitors, process control systems), adequate external (stakeholder) support, clear criteria for safe operation (boundaries stoplight model clearly defined)? Are communication lines available and used? Swift allocation expert knowledge/ skills: "introduction of an ad hoc crisis team"?
3. Is there redundancy in support functions and information processing?

Learning

1. Learning organization, learning from incidents process: individual, team and organizational learning (AARs, toolboxes, training, etc.).
   a. What inhibits learning, i.e. how is the sanctions policy applied in practice? Did the company receive fines, instructions of external bodies? How did they deal with them? What is the result of the remedial approach?
   b. Are rules, procedures regularly revised/ discussed in the organization (with management)?
   c. Can dilemmas be discussed openly in the organization (with management)?
   d. Is information from task evaluations stored (e.g. repositories), easy accessible and shared throughout the organization?
   e. Are compliance vs. resilience cases applied in training and toolboxes?

Outcomes

1. When procedure doesn't help anymore how does the team/ organization react? Is the organization equipped to this? How does one decide to activate additional resources? Why is the organization able to do so or not? In case of:

   o   An incident/ accident/ disturbance/ stressors
   o   Cascade effects (quick succession of events during operational disturbance)
   o   Fragmentation of the system (paralyzed decision making, incompatible goals different actors)
   o   Decompensation (not be able to keep up with the pace of events, or dealing with variations in the working tempo) (Woods and Branlat, 2008)

Annex 2 Resilience strategies and tactics (patterns, heuristics) (to transform "resilient inventories" into "resilience capabilities"

Operationalization of resilience strategies

Resilience Strategies are means (people, procedures, methods, techniques) to mobilize and leverage the utilization of the resilient inventory (the resilience resources) into operational capability, e.g. in terms of adaptive clusters.

A strategy utilize the inventory (resources) by (re)designing e.g., resilience oriented human-system interaction or crew composition; by providing resilience oriented operational tools and procedures, resilience oriented trainings for individuals (coping with stress), teams (team dimensional training) or organizational campaigns, etc. Example outcomes of applying these strategies may be, at an individual level: being well rested, knowledgeable, timely, able to cope with stress, etc.; at the team level: supporting behavior, mutual understanding; at the organization level: ensure trust; financial buffers.

The "Big Five" personality traits, also known as the five factor model (FFM), is a psychological model based on common language descriptors of personality[56]. Salas et al. (2005) raise the question of a potential "Big Five" analogy related to teamwork. They highlight *adaptability* as one of several coordination mechanisms of teamwork; the ability to adjust strategies based on information gathered from the environment through the use of backup behavior and reallocation of intra-team resources. Team adaptability is important for being able to alter a course of action or team repertoire in response to changing conditions (internal or external), and therefore also inherent to a resilience strategy.

Salas et al. also us the notion of *behavioral markers* (ibid, p560) related to the characteristics of tram work. For adaptability, these are:
- Identify cues that a change has occurred, assign meaning to that change, and develop a new plan to deal with the changes.
- Identify opportunities for improvement and innovation for habitual or routine practices.
- Remain vigilant to changes in the internal and external environment of the team.

These are also potentially useful for TORC purposes. All strategies referred to in this Annex can be associated with, and identified by means of the above behavioral markers for adaptability.

Based on additional literature research several strategies, heuristics, patterns tactics, and practices to support the development of resilience are mentioned below. The strategies and tactics shared in the articles have been used to build the abilities to respond, monitor, anticipate, and learn in high cyclical load situations as part of the development of thr TORC Game, as well as in piloting. They could be applied to other situations as well, such as responding to emergent issues in a maritime context. To better structure our findings we decided to adhere to the 'framework' used by Lay, Branlat & Woods (2015). Moreover, the practices mentioned vary in scale: some apply at the level of the individual or team, while others apply to the (operational) project level, and others apply across the organization. Examples of strategies are:

1. Manage deployed resources
2. Provision of extra resources
3. Manage priorities

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[56] https://en.wikipedia.org/wiki/Big_Five_personality_traits (last downloaded Oct 28th,. 2016)

4. Support processes of sense making
5. Support reflective processes
6. Anticipate resource gaps and needs
7. Anticipate knowledge gaps and needs
8. Use questions to trigger learning.

In the tables below, it will be indicated how these known organizational functions work in a resilience context.

The tables may also be used as resources for developing local strategies tailored to needs of a specific training client. E.g., when used to gather background information through interviews, the respondent could be asked to read the statements described below and have to indicate how far they agree or disagree with the statement. Scoring could be based on a 6-point Likert scale used across all items, ranging from 1= strongly disagree, 2 = disagree, 3= neither disagree nor agree, 4 = agree, 5 = strongly agree to 6= do not know. Alternatively; never – sometimes – regularly – often – always – do not know.

At this time there is still insufficient data to calculate benchmark scores and thereby it is not possible yet to determine if the score on a single item can be judged as (in)adequate for a given population. In the piloting, a criterion of 40% for assessing the scores to determine items that needed to be improved was used. For example, when more than 40 % of the respondents gave a negative response to an item, then this is seen as a signal that something needs to be done to enhance resilience. Likewise, positive results can be used to encourage certain resilient behavior. To translate answers in line with our binary resilience output matrix (+ = positive score, — = negative score) the following demarcation is used:

— = negative scores →1= strongly disagree, 2 = disagree, 3= neither disagree nor agree (3 is included because we consider this score as insufficient to enhance resilience)
+ = positive scores → 4 = agree, 5 = strongly agree

In the following, a list of prototypical resilience strategies are described in a joint table format, and proposed as a resource for local development and adaptation.

Strategy	Manage deployed resources
Ability	Respond
System level	Organisation, team
Description	In case of high load situations already existing resources in the organisation need to be deployed to respond to the emerging situation successfully. Behavioral preparedness means taking actions and making investments before they are needed to ensure that an organization is able to benefit from situations that emerge.
Operationalization	In case of high load situations: 1. Competing goals are shifted to only perform the critical tasks at hand 2. Roles within the team are shifted to only perform the critical tasks at hand 3. Less experienced people are used for less complex work 4. More oversight is provided in addition to "do" work 5. Additional buffers are added to diminish the work load 6. The team adheres to established work orders/ procedures 7. It is monitored if procedures / work orders are followed the right way 8. If procedures aren't followed the right way this will be corrected
Solutions	Expert coaching
References	Lengnick-Hall et al., 2011; Lay, Branlat & Woods, 2015; Gawande, 2010;

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Strategy	Provision of extra resources
Ability	Respond
System level	Organisation, team, multiparty
Description	In case of high load situations already existing resources in the organisation can get depleted and the provision off additional resources (from outside the company) might be necessary to respond to the emerging situation successfully.
Operationalization	In case of high load situations: 1. Assistance is requested of an expert 2. A special team is formed during the period that the system is stretched close to its limits for heightened state of coordination and help 3. The team has the authority to add or move resources 4. A forum is provided to escalate issues to management's attention 5. A cross-organization team is formed to smooth political tensions that arise during periods of high stress 6. Collaboration with expert centres takes place 7. Information is shared with relevant stakeholders 8. Stakeholders are involved in the process to develop solutions and actions to the identified risk/ emerging situation 9. It is monitored if other parties receive the right information 10. It is monitored if the crew receives the right information from other parties 11. Measures are taken if information sharing is not going right 12. Other parties are involved in developing solutions to resolve the emerging situation 13. It is monitored if the expertise of stakeholders is optimally used 14. The organisation uses its (broad) resource networks
Solutions	
References	Lay, Branlat & Woods, 2015; Johnsen, 2008;

Strategy	Manage priorities
Ability	Respond
System level	Organisation, team
Description	In case of high load situations existing resources in the organisation can get depleted. To prevent this the capacity limits on various system levels must be adjusted to respond to the emerging situation successfully.
Operationalization	In case of high load situations: 1. Stressors (both physical and mental) are removed from people 2. Tasks are shed by not doing, postpone, do less frequently, or move tasks to other persons 3. The load is shed by moving or declining projects 4. A different management style is applied considering how people respond when they are close to their limits (fatigued, stressed) because they can be more forgetful, less attentive and may miss things 5. Someone is responsible for task prioritization 6. Procedures are used to prioritize tasks 7. Time is increased to do prioritized operational work 8. Team members activities are monitored 9. Attention is redirected to perceived priorities 10. Team members implicitly redistribute responsibilities 11. Team members explicitly assign decision making activities
Solutions	Use of human performance tools such as peer checks.
References	Lay, Branlat & Woods, 2015; Joyekurun, Amaldi & Wong, 2007;

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Strategy	Support processes of sense making
Ability	Monitor
System level	Team
Description	In case of high load situations it is crucial to re-establish common ground by a process of communicating, testing, updating, tailoring, and repairing mutual understanding of the emerging situation?
Operationalization	In case of high load situations: 1. Someone steps back from (or out of) their usual role to gain a broader perspective on the emerging situation 2. The team forms a mental picture of the significance of the information for the tasks of each member 3. The team checks that the shared information is clearly understood 4. The people in the team explicitly discuss the allocation of tasks and responsibilities 5. The team checks whether the information is correct 6. The team forms a mental picture of how the situation develops 7. The people in the team ask each other critical questions to get a clear idea of the situation and their tasks 8. The people in the team share relevant information in time and on their own initiative 9. Team members address each other when they have different understanding about what is going on 10. The people in the team hesitate to speak out openly when they think differently about the solution 11. The team actively searches for information to get a clearer understanding of the situation
Solutions	**Real Time Risk Assessment** : respond to risks by tapping into current, diverse knowledge and shared experiences, in an organic, interconnected way and bring it to bear at point and time of need to address emerging situations (Lay, Branlat & Woods, 2015). **2-Minute drill**: a practice for increasing situation awareness by directing attention to the physical workplace and work with an intention of creating foresight (Lay, Branlat & Woods, 2015). **Lightning round** (cf. command huddle): a meeting designed to support coordinating, prioritizing, and understanding role contributions to the team. Share information, make requests for action, ask questions, discuss difficulties, offer help (Lay, Branlat & Woods, 2015). Collaborative cross-checking (Patterson et al., 2007) Collaborative cross-checking is a strategy where at least two individuals or groups with different perspectives examine the others' assumptions and/or actions to assess validity or accuracy. (1) reveal hidden assumptions; (2) clarify goal trade-offs; (3) explore new regions of a solution space to satisfy competing goals;

	(4) identify unintended consequences of actions (''side effects'');
	(5) identify exceptions and ''boundary conditions'';
	(6) identify possible contingencies;
	(7) identify information gaps;
	(8) identify influential people who might support or obstruct plan.
	Personnel with weakly defined roles who are not consumed by production pressures can support collaborative crosschecking and other cognitively challenging sensemaking functions.
	Processes can be rendered more observable either by explicitly communicating the rationale behind a plan and the intent behind an order or by supporting the ability for people in loosely coupled roles to ''listen in'' on planning discussions.
References	Van der Beek & Schraagen, 2015; Lay, Branlat & Woods, 2015; Patterson et al., 2007

Strategy	Support reflective processes
Ability	Monitor
System level	Organisation, team
Description	In case of high load situations it is crucial to monitor changes in the level of risk and signs of brittleness during the emerging situation.
Operationalization	In case of high load situations: 1. Changes in the level risk are noticed 2. The point beyond which the system begins to have small failures and misses (so called yield points) is monitored 3. Teams in the frontlines are queried on breakdowns, concerns and current capacity to handle the emerging situation (e.g. Who is at the point they can't keep up? What help is needed to add capacity, remove stressors, or free up capacity? What is impeding ability to perform? What is keeping them awake at night?) 4. Signs of brittleness in the teamwork are actively searched for (e.g. incomplete, unclear information or statuses, silo situations where workers are not optimally connected with frontlines, accuracy of assumptions, fatigue, and key individuals for whom there is no back-up?) 5. Scenarios of unwanted incidents (or fears) are explored 6. Critical differences in situational awareness between key actors are explored and resolved 7. Team members notice early warning signs 8. The organization queries frontlines on breakdowns, concerns, and current capacity 9. Team members actively search for signs of brittleness
Solutions	Develop rich forms of communication (STICC) (Sutcliffe, 2011) Develop richer forms of communication. The STICC protocol may be useful in situations such as handoffs: S = Situation ("Here's what I think is going on"); T = Task ("Here's what I think we should do"); I = Intent ("Here's why"); C = Concern ("Here's what I think we should keep our eye on"); C = Calibrate ("Now, talk to me").
References	Lay, Branlat & Woods (2015); Johnsen, 2008; Sutcliffe, 2011;

Strategy	Anticipate resource gaps and needs
Ability	Anticipation
System level	Organisation
Description	To be able to cope with high load situations the organisation has to build buffering capacity and develop reserves *before* needed.
Operationalization	1. The organization anticipates losing people and their associated capacities 2. The organization designs reconfigurable teams that can be split into smaller components depending on the need 3. The organisation pre-assigns tactical reserves to <u>planned</u> work to reduce disturbances caused by emergent work (e.g. back office personnel with appropriate experience that can be assigned during peak loads leaving active personnel available to respond to <u>unplanned</u> work with their more current skills enabling them to better handle variable situations) 4. The team prepares for unexpected situations and events that happen more often 5. There are enough people and material resources in the team to respond promptly to unexpected situations and events 6. The organization uses cross training so people can hold different roles within the team 7. The organization trains all teams in the whole process 8. The organisation invests in broad resource networks
Solutions	Training all teams in the whole process (job rotation)
References	Lay, Branlat & Woods, 2015; Johnsen, 2008;

Strategy	Anticipate knowledge gaps and needs
Ability	Anticipation
System level	Organisation
Description	To be able to cope with high load situations the organisation has to build support teams that are trained to hold various roles to unload or support frontlines in addition to regular duties.
Operationalization	1. People with a variety of backgrounds, different experiences, perspectives, paradigms and competencies are recruited 2. Workers periodically work at the frontlines to keep their skills fresh 3. The organization develops multi-skilled workers 4. The organisation invests in its human capital 5. Pre-task briefs are being held on a regular basis 6. Real time risk assessments are being carried out to address emerging situations 7. Controlled shocks are occasionally and deliberately injected into the system to test the system
Solutions	Strategic human resource management (Lengnick-Hall et al., 2011) Creating, selecting or hiring core employees with competencies that enable an organisational capacity for resilience. Foresight exercises (Koivisto et al., 2009) SECI model & SLC as dynamic shared knowledge creation processes through network building and participation of different experts; three functions: 1. Diagnosis: Understanding where we are… (e.g. environmental scanning and trend extrapolation) 2. Prognosis: Foresighting what could happen… (scenario building and Delphi method) 3. Prescription: Deciding what should be done… (roadmapping, backasting, modelling or simulation methods
References	Lay, Branlat & Woods (2015); Lengnick-Hall et al., 2011; Koivisto et al., 2009;

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Strategy	Trigger learning at all organisational levels
Ability	Learning
System level	Organisation, team, individual
Description	To be able to cope with high load situations in the future it is important to promote, facilitate and enhance learning from both good and bad experiences. Not only on the level of the team(s) but also on organisational level so organisational learning can take place as well. Ensuring proper knowledge management to prevent of overall system brittleness over time. Two aspects are important to learn adequate and effective as an organization. First, the organization must have established a good process to enable organizational learning from accidents and incidents effectively. And secondly they must ensure that the people themselves in the organization learn from experience and actively use information based on accident investigation and analysis.

Operationalization	1. Repetitive, over-learned routines are trained that provide the first response to any unexpected threat
	2. The operation is pre-planned by using simulation
	    a. Are lessons learned from the simulation?
	    b. Are lessons learned during simulation used during preparation?
	3. The operation is prepared by using safety cases
	    a. Are lessons learned from using safety cases?
	    b. Are lessons learned during safety cases used during preparation?
	4. The operation is evaluated using After Action Reviews (AARs)
	    a. Are lessons learned from AARs?
	    b. Are lessons learned during AARs used for upcoming projects or operational activities?
	5. Critical questions are asked to trigger learning when work is done
	Examples:
	    a. What was expected to happen?
	    b. What actually happened?
	    c. Where did things not go as expected?
	    d. What went well and why?
	    e. What can be improved and how?
	6. The process of facilitating trainee accredited learning is the responsibility of the whole team
	7. Instructional duties are shared around within the team
	8. Regular team meetings are held to discuss (safety related) issues
	9. There is an open communicative climate (transparent & reciprocal)

Solutions	After Action Reviews, Case Studies, Using a simulator, Using common "good" stories/safety cases (risk register) Error exposure training (Kontogiannis , 2011) Error exposure training involves learning both from personal experience to errors and from vicarious exposure to errors (e.g., watching someone else commit errors). This type of training builds more accurate mental models of trainees, prevents repetition of errors, and increases transfer of skills to novel situations.
References	Lay, Branlat & Woods (2015); Lengnick-Hall et al., 2011; Johnsen, 2008; Lukic, Margaryan & Littlejohn, 2013; Kontogiannis , 2011;

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Resource	Support shared/ distributed decision making
Ability	Responding, Monitoring
System level	Organisation, Team
Description	When unexpected problems arise, effective High Reliability Organisations loosen the designation of who the 'important' decision maker is in order to allow decision - making to migrate in tandem with problems (anomaly response). Shared decision making takes place over multiple interdependent groups and people which enables and ensures more 'rigorous' analysis on safety critical issues before final decisions about anomalies are taken.

Operationalization	In case of unexpected situations:
	1. A shared decision making process takes place
	Follow up questions:
	    a. What people are involved in making a new strategy?
	    b. What are their roles?
	    c. What is the knowledge or experience of the people involved that is important to make the new strategy?
	    d. How is this taken into account during the decision making process?
	2. There is one person that makes the final decision
	3. There are several persons involved in making the final decision
	4. Diverse perspectives are included in the analysis process
	5. Diverse perspectives are included in the decision making process
	6. There is a central place, process or person present that provides an integrated picture of the state of the response to the anomaly
	7. This central person makes this integrated picture salient to all other groups that contribute or are affected by the anomaly or the organization's response
	8. There are procedures or agreements to let crew members know to each other about the activities they are doing
	9. There are procedures or agreements on crew cooperation

Solutions	Cooperative advocacy (Watts-Perotti & Woods, 2009) This is an approach for coordinating the multiple perspectives to help groups involved expand the range of factors considered and recognize potential missteps early in re-planning decisions. And early detection and resolution of conflicts in assessment, analysis and re-planning. As a result of the method opportunities for *cross-checks* (help groups recognize when current assessments are in need of revision and help them recover from mis-assessments that arise in the process of trying to understand and respond to anomalies; does the event fall inside or outside available tools for analysis or application of standard plans) and *broadening checks* (help identify side effects of decisions or actions in re-planning and reveal the level of rigor behind assessments and recommendations) arise which result in better error correction, repair of common ground and identification of additional alternatives and contingencies. Implicitly it facilitates when to increase resource investment (time, expertise, economic, social and physical resources) to more fully understand the situation and more fully explore contingencies in re-planning. Joint activity coordination (Bergström et al., 2010)

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| | Successful coordination in joint activities requires three primary abilities:
1. interpredictability: the ability to predict the actions of other parties involved in the joint activity, including aspects such as making the own action predictable to others and sharing estimations of time and skills needed to perform a certain action
2. establishing common ground: refers to a process of communicating, testing, updating, tailoring, and repairing mutual understanding
3. directability: the ability to adapt the process to the dynamic environment of an unexpected and escalating situation |
| References | Sutcliffe, 2011; Watts-Perotti & Woods, 2007 & 2009; |

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