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BEST PRACTICE RISK TOOLS FOR ONSHORE SITES WITH DANGEROUS SUBSTANCES

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The need for tools in the transition from Seveso I to II in The Netherlands

There are about 130 Seveso II sites in the Netherlands that have to draw up a safety report and about 200 that have to draw up a Major Accident Prevention Policy combined with the development of a Safety Management System, a total of around 600 major hazard installations on 330 sites.

The Ministry of Social Affairs, the Ministry of the Environment, and the Ministry of the Interior are together responsible for the implementation of the Seveso Directive. Prior to implementation of Seveso II there were two types of safety report. There was the external safety report (EVR) which produced the risk contours relating to risks from loss of containment of hazardous substances with effects outside the site boundary, and the labour safety report (AVR) which described the organisation, hazardous processes and safety arrangements onsite for preventing loss of containment of hazardous substances with respect to protecting the workforce. It was decided that the implementation of the Seveso II Directive would be a good opportunity to integrate these regulations and come by one safety report which would fulfill the demands of the directive. Also, it was decided that the assessment of the safety report and the inspections should be performed in teams consisting of inspectors from the three ministries involved.

The Labour Inspectorate, being part of the Ministry of Social Affairs, has a long history and experience regarding the assessment and inspection of major hazard installations. The problems the Ministry had been facing in the past was:

- (1) how to assess and inspect/audit safety report and installations/organisations in a uniform way, and
- (2) that a small group of specialist inspectors (17) was being faced with a large workload of around 400 major hazard installations that had to be inspected.

Under Seveso I the Ministry used AVRIM, a uniform inspection methodology based on a checklist approach which also relies extensively on inspector expertise. However AVRIM did not cover the assessment phase, only the inspections. One of the other problems with AVRIM was that it seemed to lead more to the consideration of occupational issues than those of major hazards. Last but not least the screening of the organisation, on which there was a heavy emphasis, lacked an audit technique whereby enough attention could be given to the technical and major hazards management aspects of the installation.

Before the implementation of Seveso II, a new method was therefore developed, together with software support, called AVRIM2. Starting in 1996, the tool was developed by SAVE Consulting Scientists under the guidance of a steering committee which included policy makers and inspectors from the Ministry of Social Affairs. The aim of the new method was:

- (1) to cover the safety report assessment phase as well as the follow-up inspections;
- (2) to address major hazards;
- (3) to provide a basis for uniformity of assessment;
- (4) to provide a tool useable by the inspectors.

In other words, one tool that would not only assess safety reports with respect to major hazards but which also could be used during inspection and which would balance the attention between technical safety aspects and the Safety Management Systems.

Apart from this, AVRIM2 is a transparent assessment, inspection and audit procedure, thereby giving the opportunity for third party scrutiny. This aspect is important for a governmental organisation that deals with major hazard control.

The AVRIM2 tool has been developed so that it:

- (1) integrates the safety report assessment phase with an inspection system to check the technical Major Hazard aspects;
- (2) provides a link from the technical aspects to an audit system to evaluate the Safety Management System;
- (3) can be used to backtrack from the SMS evaluation to technical inspections.

So that the method could be used, companies would have to provide the necessary information on scenarios in the safety report. This meant that the definition of scenarios in the Seveso II directive had to be investigated, and relevant guidance for companies on the detail and amount of information was drawn up. This was done in co-operation with a large international company. The guidance was then put into regulation in order to ensure a uniform approach (Major Accidents Risks Decree '99, supported by regulation giving more detailed rules).

The Netherlands is the only country that developed such a tool prior to the implementation of the Seveso II directive, thereby ensuring that the required information for the tool will be provided by the companies. Indeed, the AVRIM2 software and theory manual is also available to companies in the form of SAVRIM which can be used as a framework for delivering information required in the safety report.

AVRIM2 provides an overall framework for assessment and inspection/audit with respect to Major Hazard safety report sites. However, for lower tier (MAPP) sites it was realised that a different approach would be required since the information that could be requested from the company was limited to the MAPP document. Lacking the technical evaluation as a starting point, another tool was developed called NIVRIM. This was produced by the Technical University of Delft together with SAVE Consulting Scientists, again under the guidance of a steering committee. This is more of a paper-based checklist approach with attention points which enables the inspection team to check whether the Major Accident Prevention Policy document complies with the requirements in the Decree. The tool also contains attention points to identify whether the safety management systems implemented by the relevant companies exist and are adequate for Major Hazards risk control. The tool is not

meant to test a complete safety management system but only those aspects falling within the Major Hazards scope.

Finally it should be also be mentioned that, after the implementation of the Seveso II Directive in Dutch law, certain sites handling dangerous substances which had fallen under the previous Labour Safety Report regime were no longer included. At the beginning of 2000 the law for these remaining sites was changed, and demands were made in a Decree and associated detailed rules for a Risk Inventorisation and Evaluation (RI&E) supplementary to that specified in the Labour Conditions Act, these supplementary requirements being specifically focused on loss of containment of dangerous substances.

For this last set of companies, another tool was developed by SAVE Consulting Scientists called ARIE, a set of paper-based checklists and detailed support in the form of explanatory text. The steering group for this development, chaired by Toptech Studies in Delft who will be responsible for providing training in ARIE, included policy makers from the Ministry of Social Affairs and representatives of the intended users of the support tool, that is the companies themselves, companies providing labour conditions services (Arbo-diensten), and inspectors from the Ministry of Social Affairs. The intention was to give sufficient support for the production of a good quality ARIE (supplementary risk inventorisation and evaluation).

Brief Overview Of Tools

In summary then, the Ministry of Social Affairs provided for the development of three tools for the use of the Labour Inspectorate specialising in Major Hazards:

- (1) AVRIM2 - Dutch acronym derived from the previous regulation meaning Labour Safety Report Assessment and Inspection Method intended for the top tier major hazard sites consisting of a detailed handbook and a software tool (both in Dutch and in English).

This tool takes the inspector through a technical evaluation of major hazard control by focusing, per installation, on a set of loss of containment (LOC) scenarios which is

agreed between the site management and the inspection team. The scenarios have to be described in terms of how they might be caused and the lines of defence against the scenarios arising and the chances and consequences of LOC. Further, it has to be demonstrated that the lines of defence against LOC are adequately managed. The inspectors follow through the steps of AVRIM2 as follows:

- Step 1 Evaluate coverage of possible events which could trigger Loss Of Containment using an Initiating Event Matrix. This consists of, on one side, a set of installation activities and associated containments causes of LOC and, on the other side, a set of direct causes of LOC. (See Figure 1).
- Step 2 A scenarios check. Here the broad classes of initiating events are considered in more detail using a set of 11 Generic Fault Trees: corrosion, erosion, external loading, impact, overpressure, underpressure, vibration, temperature (high/low), wrong equipment, operator error (no structural failure) and exceeds containment limit. These trees give a total of 125 generic scenarios. The purpose is to investigate whether the more important scenarios have been thought of. (See Figure 2).
- Step 3 Evaluation of lines of defence. Here the inspector is supported by 139 different Lines Of Defence Checklists each linked to a base event of the fault trees. These checklists consist of the different types of lines of defence, the life cycles in which they are introduced and preserved, and the associated key management tasks or “themes” involved in introducing and preserving them. The aim is to evaluate if for all the relevant scenarios a lines of defence system is in place with all the relevant preventive and protective measures. (See Figure 3).
- Step 4 Evaluation of the risk of failure of lines of defence. Here the inspector is supported by a Risk Matrix. To evaluate chance of failure and consequences for the possible failure scenarios the company should use a risk matrix and risk criteria. This gives the inspector insight into

the company's philosophy towards risks and the way they have dealt with them on that particular site. (See Figure 4).

Step 5 Evaluation of the Safety Management System. Because of the limited time it is not possible for the inspector to do a full-scale management audit of the site and installations. So, depending on the evaluations of the previous steps and together with optional use of an Organisational Typing Tool, the inspector is supported in the software by recommendations of the most relevant themes of the safety management system to be considered. There are sets of attention points grouped under 9 themes for each of 15 components of a management Control and Monitoring Loop for each life cycle phase (design, construction, operations and maintenance). The underlying concept is that the management system has a common mode effect on the lines of defence against failure. The selected attention points are used for audit on site, together with technical inspection of the condition of the installations. Weak points are identified and recommendations made. (See Figures 5, 6, and 7).

Step 6 Technical inspection component. Detailed support is currently being developed, together with an option in the software for "backtracking" from weak points in the management system to associated failure scenarios and lines of defence.

- (2) NIVRIM - Dutch acronym meaning "Not Safety Report Inspection Method" intended for lower tier (MAPP) sites consisting of a handbook explaining its development, and providing attention points, questionnaire checklists, explanatory text, and evaluation schemes (only in Dutch). The system checks the MAPP document and the safety management system. The latter should consist of the following components as laid down in the Seveso II directive:
- A. organisation and personnel
 - B. identification and evaluation of major hazards
 - C. operational control
 - D. management of change

- E. planning for emergencies
- F. monitoring performance
- G. audit and review.

It must be shown that these components are part of the management system and that the safety management system is actually working practice. For that reason, the NIVRIM tool checks three aspects of the safety management system components: whether it is present, whether it is complete and whether it is actually working (verifiable).

- Step 1 The inspection team prepares the inspection based on the Notification and requests underlying documentation (Major Accident Prevention Policy document, written procedures and so on). Step 1 aims at achieving insight into the risks of major accidents and the characterisation of the establishment.

- Step 2 The inspection team checks whether the establishment has a Major Accident Prevention Policy document and whether it complies with the requirements of the Dutch law in which the Council Directive is implemented. The aim is to control the completeness of the document.

- Step 3 The inspection team holds a dialogue with the establishment's managing director to identify whether the establishment has a logical explanation of their MAPP and why the risks can be best controlled as laid down in this document. The aim of step 3 is to identify the strong and weak spots of the establishment's safety management system.

- Step 4 The inspection team investigates the requirements of the safety management system (the above mentioned seven points) in greater detail based on the written material and conversations with relevant staff members. Additionally, the inspection team visits the major hazard installations on site and talks to personnel (operators, maintenance people) to check the effectiveness of the written procedures. The aim of

step 4 is to check completeness in greater detail and to verify the effectiveness on the work floor.

Step 5 The inspection team assesses their findings on the quality of the Safety Management System and formulates recommendations with respect to the weak spots. The findings are mapped on to the AVRIM2 Control and Monitoring loop (developed for inspections of higher tier establishments) to identify whether the establishment's approach to safety control is systematic.

Step 6 The inspection team officially rounds up the results of the inspection and notifies the establishment accordingly.

For steps 1,2 and 4 supporting questionnaires are prepared, for step 3 there is a list of attention points, and for step 5 the AVRIM2-loop is mapped on to the questions of step 4.

Figure 8 gives an example of a NIVRIM checklist.

(3) ARIE - Dutch acronym meaning Supplementary Risk Inventorisation and Evaluation, intended for companies with installations handling dangerous substances excluded from the Seveso II Directive but previously Labour Safety Report (AVR) installations. ARIE is a handbook (only in Dutch) consisting of six steps, each step being composed of an overview, a checklist, and evaluation scheme and explanatory text where it can be checked whether an ARIE fulfils the requirements. ARIE is based on taking relevant support from both AVRIM2 and NIVRIM. The steps are as follows:

Step 1 Collect documentation in order to get an overview of the organisation and its approach.

Step 2 Check the inventorisation and evaluation of the risks of dangerous substances.

Step 3 Check the safety policy and safety management system.

- Step 4 Check the plan of approach for dealing with weaknesses and improvements.
- Step 5 Inspection of measures and audit of the Safety Management System.
- Step 6 Summing up.

The New Approach Of AVRIM2: Technical Management Links

One of the foundation stones of AVRIM2 is the concept that a Safety Management System should be tailor made for the technical system and its associated risks. This concept is derived from the hands-on experience and observations of the policy makers and the Labour Inspectorate of the Ministry of Social Affairs and Employment. The concept requires that:

- the regulator must first assess the technical system safety before examining the safety management system.
- the company must show how prevention of the accident scenarios of the technical system is managed by the safety management system.

Seveso II does not explicitly require a company to make a link between the technical system descriptions in the safety report, and the demonstration of the working of the management system in the context of major hazard control. However, the company has to be able to show that it is effectively managing the major hazards.

To make this process as efficient as possible, the “lines of defence” concept of AVRIM2 was further developed in order to provide links between technical and management systems for major hazard (dangerous substances) chemical plant, where:

- the description of the ways in which the hazards might be realised is based on “scenarios” which are individual or combinations of failures in the technical system (equipment and procedures) for keeping the dangerous substances contained.
- the management system is linked to “lines of defence” (LODs) which prevent and protect against scenarios.

The principle is shown in Figure 9 where the complete management system can be reflected in the way a limited number of technical elements are managed. The basic management principles which apply to one part of the technical system can be expected to be found amongst the other parts, and only that much of the technical system has to be analysed to demonstrate these principles.

The basic scheme for making these scenario descriptions is shown in the “loss of containment bowtie” in Figure 10 where the idea is that for a limited number of LOC situations a detailed working out of causes and effects and lines of defence should be provided.

Through the links project, support was provided for the AVRIM2 method in the software by making a generically complete set of links between the generic scenarios model (11 generic fault trees with a total of 139 basic failure events and 125 scenarios) and the management system (4 life cycles, 9 management themes per cycle) through a set of lines of defence types (4 types). For every one of the 139 base events, which represent the whole system of generic failures, a number of links to the management system were made based on informed judgement (actual causes of accidents, engineering practice, logical links etc.). The set of links for any particular base event was called “Checklist Lines of Defence”.

A “Checklist Lines of Defence” is made from the following components:

Basic Event

This is the starting point for generating the checklist. The basic event is a failure in the technical system which alone or in combination with other events gives the failure scenario. For example, “substance introduced in wrong form” is one of the basic events in the scenario “runaway reaction”.

Type of Line Of Defence

Four types of LOD were defined (see below). A basic event could have one or more types of LOD. For example, “failure to shut off feed in time” can have both process instrumentation and control LODs and work system LODs.

- **Physical LODs** which prevent failure of the physical containment itself, such as thickness of metal, physical protection against internal and external conditions.
- **Process instrumentation and control LODs** which prevent failure of the measurement and/or control of the process, which includes process instruments/control loops, pumps, filters etc. (in effect, any equipment or instrument that affects the parameters of the process conditions).
- **Barrier LODs** which prevent failure of the containment through a protective device or system which diverts material or energy when there is a demand on the containment system, such as pressure relief, or a barrier to prevent impact from vehicles.
- **Work-system LODs** which prevent events that may place demands on physical systems and include plans, procedures, instructions and other support systems (like the ergonomics of information displays or operational controls) which help to prevent human error or omission.

Life Cycle

For each LOD there are relevant life cycles in which the LOD is introduced and preserved, such as the Design phase for determining the correct protection specifications against corrosion.

The life cycles are:

- Design (and modifications)
- Construction
- Operations
- Maintenance, Inspection and Testing

Management Theme per life cycle

This is the point at which the technical system is connected to the management system. In effect, the life cycles in which the LODs are introduced and preserved are considered in terms of the key management tasks or “themes” involved in introducing and preserving them. A list of one or more management themes under each life cycle is the concluding part of the Checklist LOD. The themes are derived from AVRIM2’s management model. For every life cycle there is a management model, the Control and Monitoring loop, which has a number of components of control and monitoring linked together as a self regulating, self improving control system (see Figure 5). For each of the 15 loop components of the system there are common

themes which run through them. Attention points for auditing this system are grouped under 9 themes, which recur under each of the 15 loop components. These themes are more or less common across all life cycles. Selections of a limited number of themes make it possible to carry out a restricted audit of the control and monitoring loop (see Figure 6). These management themes appear in every life cycle:

- Knowledge of hazards/risks
- Use of standards
- Control of safety-production conflicts
- Formal safety studies
- Safe procedures
- Manning levels, competence, training
- Human factors in error management
- Supervision and checking
- Capturing experience, incident/near miss analysis

Figure 2 gives a hypothetical case of an 'LOC situation' using AVRIM2 software. The hypothetical case is a C-CAP transfer pipework leak. Figure 2 shows the set of generic fault trees connected to this LOC situation. AVRIM2 software always automatically connects all the generic trees to a named LOC situation (Note: the effect tree part of the bowtie in Figure 10 has not been connected yet). In Figure 2 on the right hand side of the screen, one of the generic fault trees has been expanded. It is possible to do this with any selected tree. Numbered events in the expanded tree are the basic failure events. In the example in Figure 2 the failure event is 'not replaced like with like'.

Every basic event in every tree has an associated "Checklist Lines Of Defence" This is a suggested list of the components of a lines of defence system against the occurrence of the basic failure event. An example of a Checklist LOD in AVRIM2 software is shown Figure 3 for one base event from the Overpressure tree. This base event 'blocked outlet leads to overfilling' is one event in a scenario which comprises 6 base events (the scenario definition is also shown in the figure). Whenever a management theme is marked up in a Checklist LOD, this is reported back in the software in the Management module as shown in Figure 6. The

thermometer scales on the left indicate the proportion of LODs marked positively or negatively (darker portion of the strip indicates positive), and the number is the total number of basic events assessed.

The connection of failure scenarios to the management system in AVRIM2 enables a management system to be addressed in a site specific way in terms of the specific major hazard scenarios (technical system failures). What is interesting is that it is now possible to backtrack from a management theme to a connected set of scenarios. For example, taking the theme of 'conflicts between safety and production' in the operations and maintenance phases, this is linked to the following types of scenarios:

erosion, failure to detect accelerated corrosion or deterioration in quality of materials, corroded (not maintained/inspected) equipment, unrepaired damage to corrosion protection, operating outside the design safety limits, blockage in pipe-work and associated equipment resulting in overpressures, runaway reactions, wrong spec equipment due to incorrectly installed equipment including due to not having the right parts available and maintenance being carried out at the wrong place, not replacing like with like, overfilling, failure in automatic stop devices due to lack of maintenance, removing and not replacing equipment supports after maintenance, starting up an operation with open equipment, failing to properly clear out hazardous contents before maintenance.

The ability to backtrack leads to interesting possibilities for beginning an evaluation in the safety management system as shown in Figure 11 and frees inspectors from having to begin with scenarios. This is also useful for investigating Major Accident Prevention Policy sites where a technical evaluation by the company is not required under Seveso II.

Experience So Far

Both AVRIM2 and NIVRIM have been tested in the field. A test of ARIE is underway. One company using AVRIM2 found that most of the components of its management

system could be linked to a detailed analysis of the lines of defence systems for the failure of a single containment system (just one LOC situation for the bowtie model of Figure 10). Inspectors are beginning to find that analysis of a limited number of scenarios selected for installations across a site can capture the important information about the major hazards and their control. For auditing, the inspectors have applied AVRIM2 in test cases of both top tier and lower sites with good results. However, for checking whether the company meets the regulation in having the relevant components of the SMS they prefer to use the simple NIVRIM method. All the inspectors have undergone training in the use of AVRIM2 software. The main problems seem to be its complexity (a problem currently being solved) and that it can be time consuming in entering the data. However, it has been described as an excellent tool and there has been a positive response to the fact that it is now available to companies. One company stated that the use of AVRIM2 demonstrated the first real safety benefit for them in producing a safety report while another is planning to adopt the approach for its European operations. In general, the feedback on AVRIM2 is that it is the right approach for dealing with major hazards.

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Figure 1: Part of the Initiating Event Matrix in the AVRIM2 software

Avrim2 - D:\installations\SZW1.inr - SZW Plant

File Site Analyse Lines Of Defence Analyses Organisation and Management Reports Options Help

Initiating Events | Scenarios and Lines Of Defence | Risk Matrix | Organisational typing | Management system

Initiating Events (Report) Evaluation

Activities	Containment	Corrosion	Exceeds Containment Limits	Erosion	External Loading	Impact	Operator Error	High pressure	High/Low Temper	Low pressure	Vibration	Wrong Equipment
Storage	Atmospheric tanks											
	Pressurised vessels											
Transfer	Pumps											
	Compressors											
	Pipework											
	Ductwork											
Sampling	Sampling points											
	Sample container											
Processing	Pumps											
	Compressors											
	Heat Exchangers											
	Pipework											
	Pressure vessels											
	Atmospheric tanks											
	Reactors											
	Furnaces											
Packaging	Drums											
	Pipework											
	Pressurised containers											
	Packets											
	Bags											
Transport	Pressure Vessels on Rail car											
	Pressure Vessels on Road tank											
	Pressure Vessels on Ship											
	Pressure Vessels on Barge											
	Atm tanks on Rail car											
	Atm tanks on Road tanker											
	Atm tanks on Ship											
	Atm tanks on Barge											
	Loading arms											
	Lower											

Figure 2: AVRIM2 software showing LOC situation and connected direct causes (left) and base events of one of the generic fault trees (right). Base event for scenario 2.2 is highlighted.

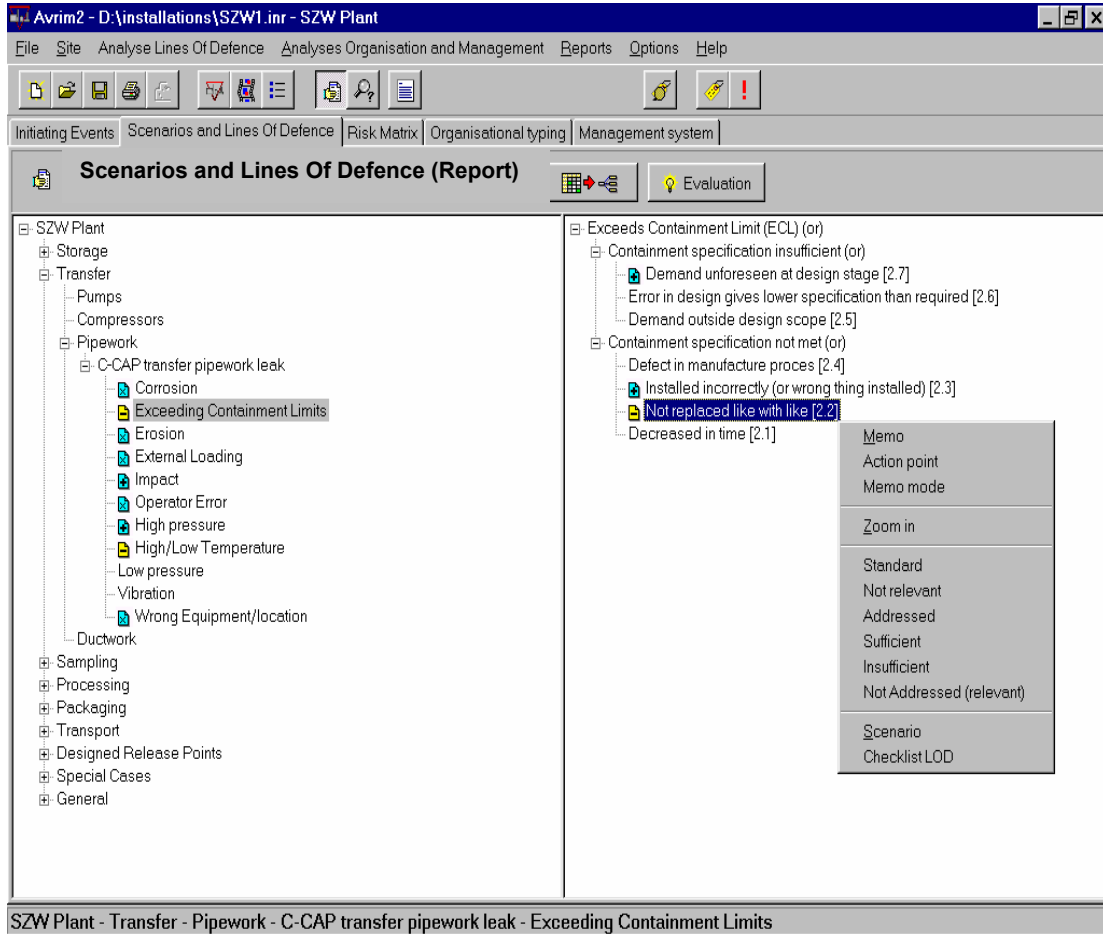


Figure 3: Checklist Lines Of Defence for one of the basic events in Scenario 7.23, together with a description of the complete scenario. Each of the basic events in the scenario has its own checklist.

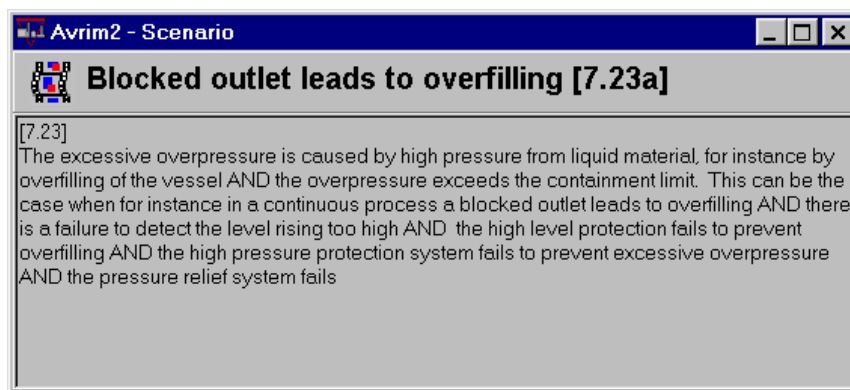
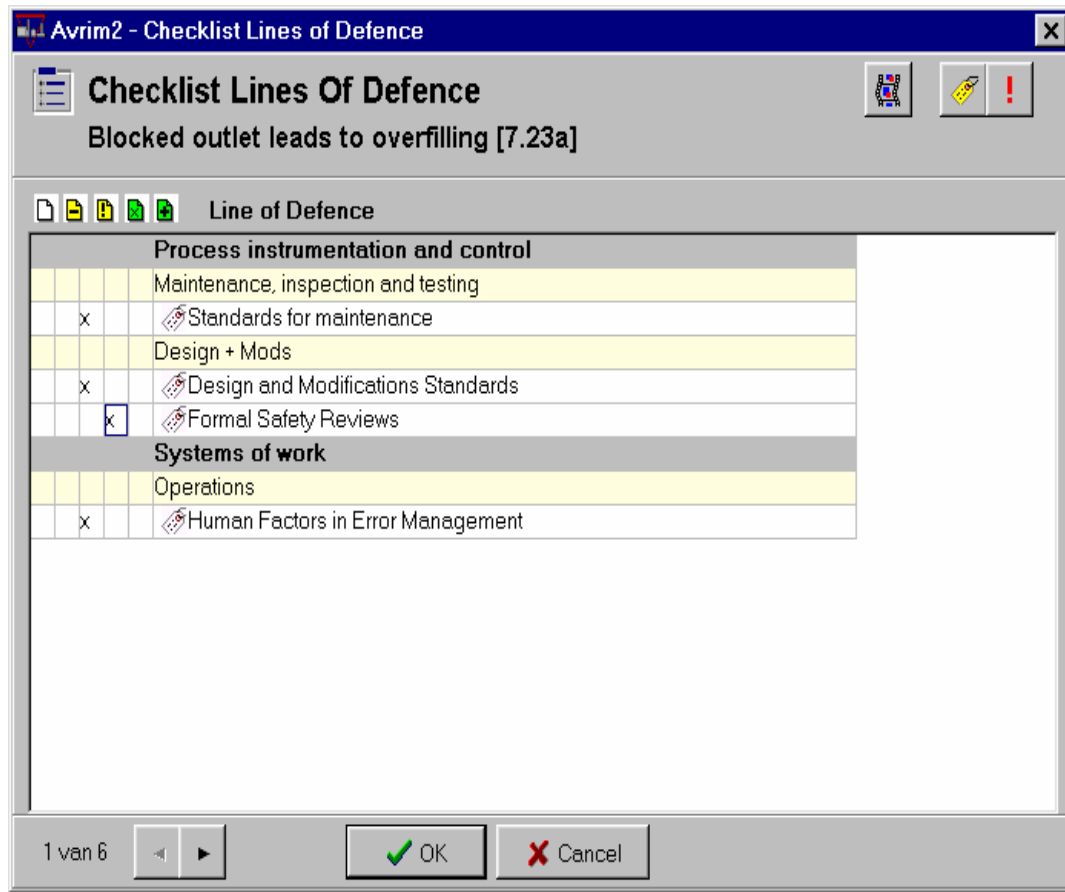


Figure 4: AVRIM2 Risk Matrix

Likelihood of loss of containment	Consequence severity				
	Negligible	Minor	Serious	Major	Severe
Very high	O	X	X	X	X
High	O	O	X	X	X
Average	-	O	O	X	X
Low	-	-	O	O	X
Very low	-	-	-	O	O

KEY

- X Unacceptably high risk.
Company should reduce by prevention/protection.
 - O High risk.
Company should address cost-benefits of further risk reduction
Inspector should verify that procedures and controls are in place.
 - Acceptable risk. No further action required
-

Figure 5: AVRIM2 Control and Monitoring Loop

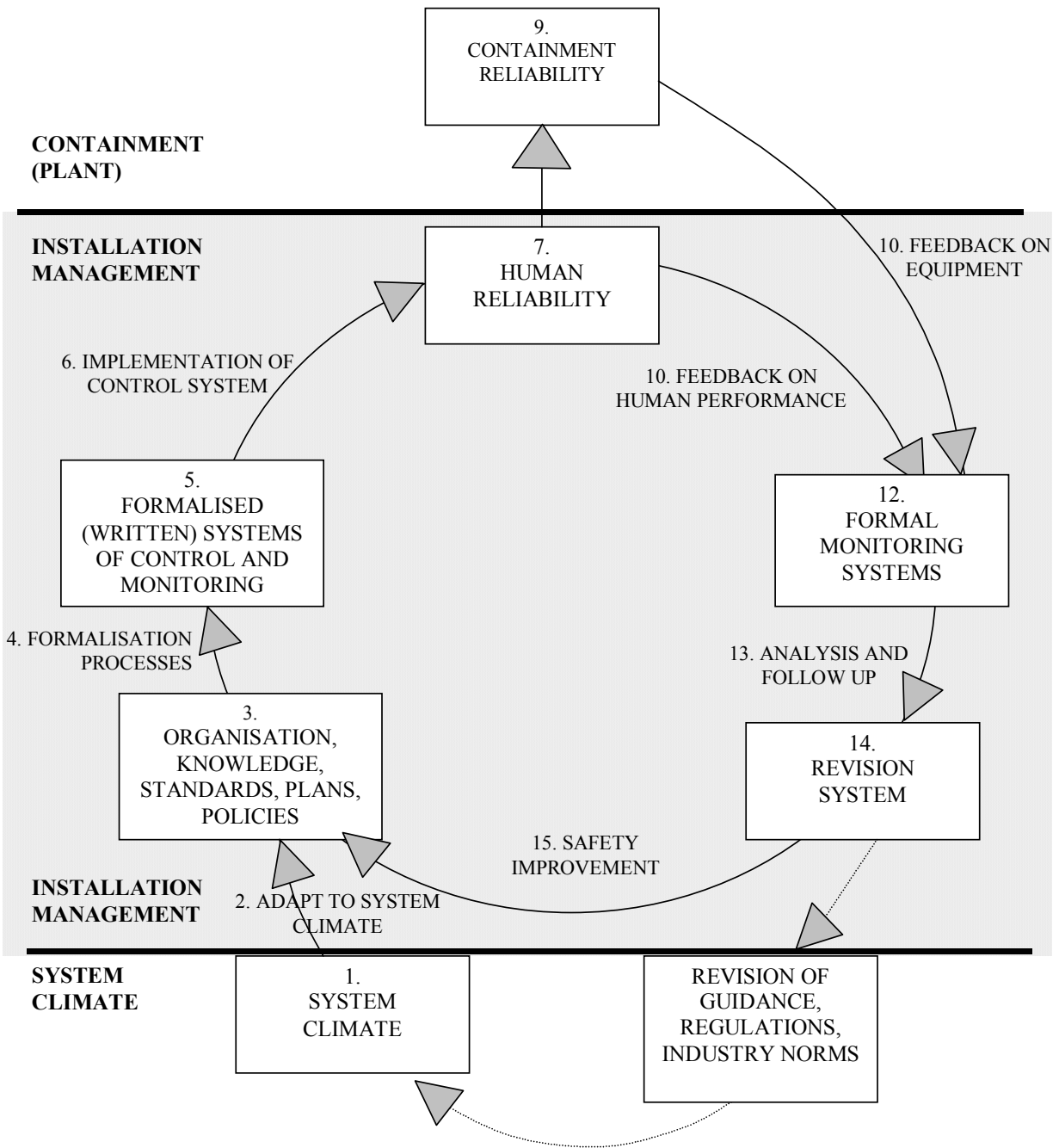


Figure 6: The scoring of management themes in the Checklists LODs reappears in the management module to give guidance on what themes are strong or weak with respect to management of site specific scenarios. The theme “Design and Modification Standards” has been selected for further analysis in an audit of the management system.

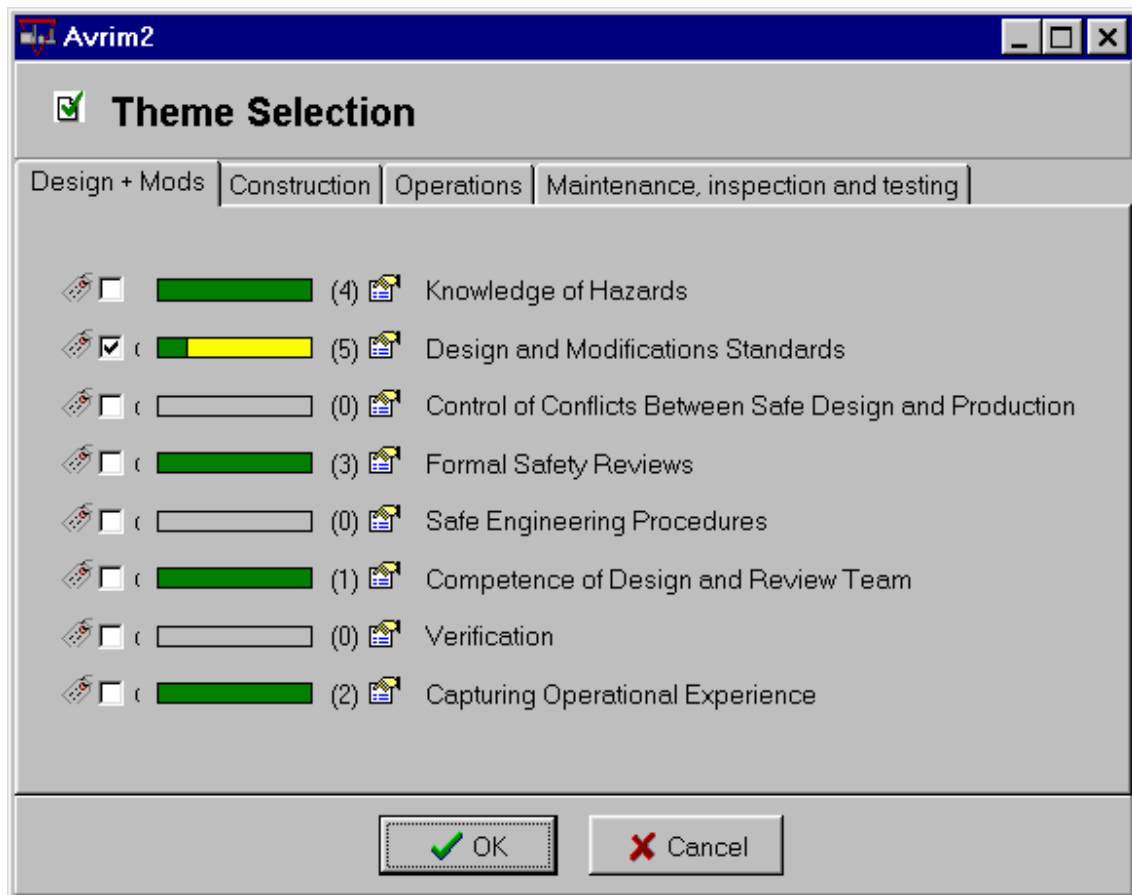


Figure 7: Example of AVRIM2 attention points for the SMS audit

Avrim2

Attention points

Production Manager, Safety Manager, Engineering Manager, Human Resources Manager, Shift supervisor

Design + Mods | Construction | Operations | Maintenance, inspection and testing

Attention points (insufficient sufficient)

Knowledge of Operational Hazards	
<input checked="" type="checkbox"/>	List of installation hazards and hazard sources
<input checked="" type="checkbox"/>	Register of dangerous substances
<input checked="" type="checkbox"/>	List of Emergency scenarios
<input checked="" type="checkbox"/>	List of temporary arrangements / modifications
Operational Standards	
<input checked="" type="checkbox"/>	Safety, Health and Environment policy: Safety priorit
<input checked="" type="checkbox"/>	Safety, Health and Environment policy: Signed
<input checked="" type="checkbox"/>	Safety, Health and Environment policy: Reproduced
<input checked="" type="checkbox"/>	Format of Documentation: consistent with company of
<input checked="" type="checkbox"/>	Job descriptions: Employer or operators job
<input checked="" type="checkbox"/>	Job descriptions: Specify
<input checked="" type="checkbox"/>	Written procedures for management activities
<input checked="" type="checkbox"/>	Minutes of meetings: Of safety committees/safety gro
<input checked="" type="checkbox"/>	Memos: Such as special safety instructions
<input checked="" type="checkbox"/>	Documentation: Safety targets, plan, what completed
<input checked="" type="checkbox"/>	Documentation: Operational safety performance indi

Link/Component

- Externe factoren
- Link 2
- Component 3
- Link 4
- Component 5
- Link 6
- Component 7
- Link 8
- Component 9
- Link 10
- Link 11
- Component 12
- Link 13
- Component 14
- Link 15

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Figure 8: NIVRIM Checklist for the component Organisation and Personnel (where P=present, C=complete, V=verified)

	P	C	V
1. Are tasks, responsibilities and authority of own personnel (at all levels in the organisation), involved with major accident risks control prescribed, for each phase of the life cycle? <ul style="list-style-type: none"> ▪ Design/changes ▪ Normal operation ▪ Maintenance during normal operation ▪ Maintenance during 'stops' 			
2. Are tasks, responsibilities and authorities of personnel of third parties (contractors) involved with major accident risks control prescribed?			
3. Is the communication and supply of information on major accident risk control organised (e.g. safety committees, safety representatives, top management commitment?)			
4. Are requirements formulated for own personnel regarding major accident risk control (knowledge and skills, training and education)?			
5. Are requirements formulated for third party personnel regarding major accident risk control (knowledge and skills, training and education)?			
6. Are training and educational programs available for own personnel, in which major accident risk control is explicitly dealt with?			
7. Is there an alert mechanism that responds to external signals which might be of influence on the organisation and demands put to the personnel?			
8. Are there checks whether own personnel (or third party personnel) comply with the requirements formulated for major accident risk control?			
9. Does daily work comply with the division of tasks, responsibilities and authority?			
10. Does communication and supply of information take place according to the established structures?			

Figure 9: Technical-Management-Technical Connections

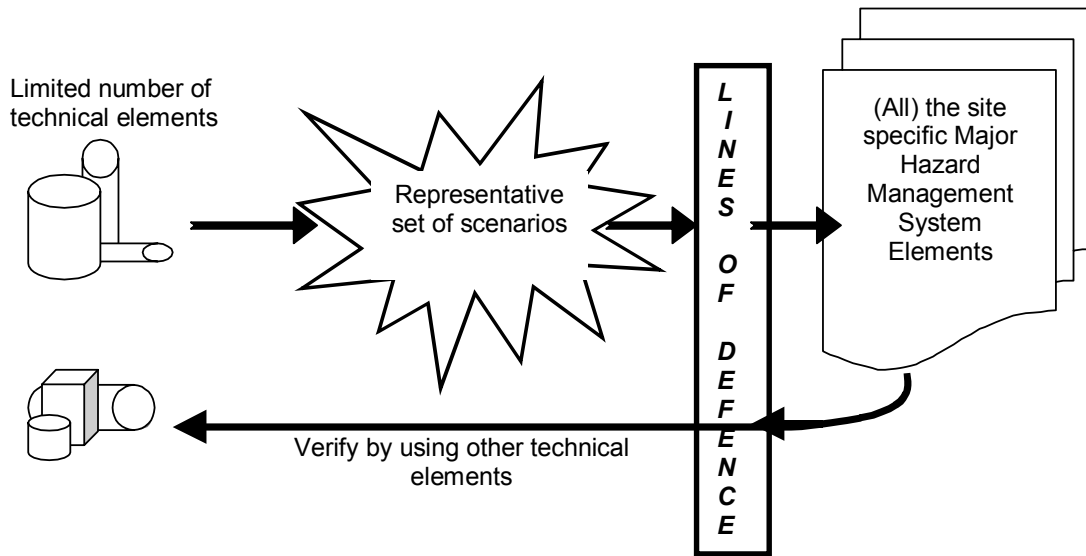


Figure 10: Schematic representation for detailed scenario descriptions ("bowtie"), where LOC=Loss Of Containment and LOD=Line of Defence

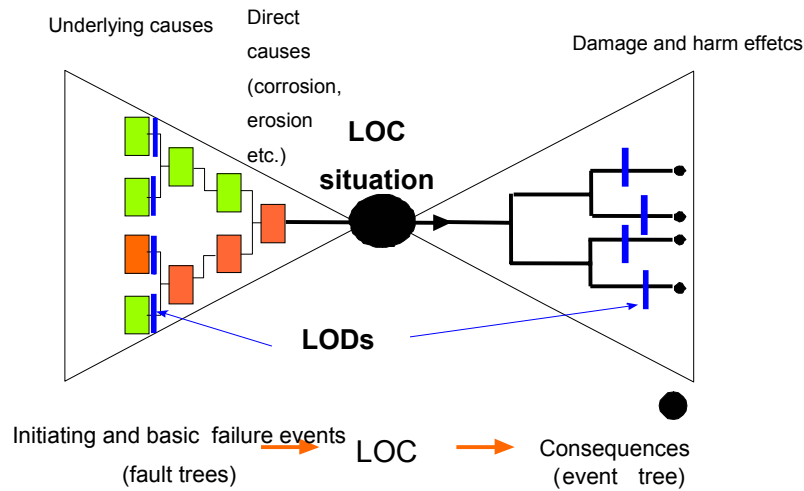


Figure 11: Scenario-Management Links study enables investigations to begin in the management system and link potential the technical system weaknesses.

