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Checklists for surveying and assessing industrial plant handling materials and substances, which are hazardous to water

№ 3

In-Plant pipeline safety

For our Environment

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In-Plant pipeline safety

by

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Recommendations of the International River Basin commission for in-plant pipeline safety

1. Pipelines must enclose substances hazardous to water in a safe manner.
2. Pipelines must be adequately dimensioned in accordance with the physico-chemical properties of the substances being handled. The tightness of pipelines must be demonstrated by means of generally recognised testing method.
3. Pipelines must be able to withstand mechanical, thermal, chemical and biological stress in accordance to the purpose of use and must be durable according to the purpose of exploitation. This applies also to detachable connections (flanges and or similar connections), pumps and other fittings.
4. Drifting and declivity of the pipelines must not endanger their safety and tightness.
5. Pipelines must be adequately protected against mechanical damages, e.g. being bumped by vehicles.
6. Verification of tightness and resistance to corrosion should be subject to repeated checks by experts.
7. Proof is required that the rate of attrition between the verification intervals does not result in any inadmissible weakening of the pipelines and in particular that localised corrosion is ruled out.
8. Where the material of the pipelines is itself not sufficiently tight, suitable coatings are to be applied or equivalent safety measures should be taken.
9. Safety aspects must be taken into account when installing pipelines (underground/above-ground).
10. Special safety measures are to be taken for pipelines in which the substances transported can cause electrostatic charges.
11. Underground pipelines, any detachable connections and valves should be installed in a monitored leak proof inspection shafts. The technical construction of such pipelines should comply with one of the following requirements:
    - they must have double-wall, any leaks in the pipeline wall must be indicated by an approved automatic leak indicator, or
    - they must be designed as suction lines in which the liquid column is interrupted in the event of leaks, or precautions against the discharge of transported products must be taken in regular intervals, or
    - They must be equipped with a suitable protective pipe or be laid in a conduit; any escaping substances must be visible in a monitoring device.

    If, for safety reasons, none of these requirements can be fulfilled, only equivalent safety measures may be taken.
12. Concept, installation, inspection, maintenance of and alterations to the pipelines must be executed and documented professionally.
13. Pipelines must be labelled appropriately.
14. The position and layout of the pipelines must be documented.

Checklist for monitoring the implementation of the recommendations

General characteristics of pipeline

This assessment applies to the:

❒ Complete system ❒ Sub-system ❒ Individual pipe

❒ Aboveground ❒ underground

Name of substance:

(Details in the check list no. 1 „Substances“)

Material of pipeline:

Diameter: mm or DN

Design pressure: bar

Maximum operating pressure: bar

Operating temperature: °C

Size of the pipeline m

Remarks:

1 Pipes shall securely contain all water-polluting substances

1.1 Could the tightness of the existing pipelines be ascertained through a simple visual inspection (as far as possible)?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

1.2 Under certain circumstances secondary containment and/or tight surfaces must be installed under over ground pipelines, their connections and fittings as prcautionary measure in case of accident.

1.2.1 1.2.1. Are the capacities of the available secondary containments when handling WRC 1 liquids bigger than the needed capacity?

item		Secondary containment	Yes	No
1	Pipeline	-		
2	Fixed connections or the connection is designed in such a way that the seal can not be pushed out of place	-		
3	Other connections	R1		
4	Connection flange like in item 2 and fitting with stuffing box seal or bellows-type mechanical seal or monitored double wall	-		
5	Other fittings	R1		

R1 = Retaining capacity for the amount of water hazardous liguid that could leak out before a suitable (e.g. closing the untight section of the plant or sealing up the leakage)

❒ Action ❒ No action

Remarks:

1.2.2 1.2.2. Can flexible in-plant pipelines be installed and used above a surface which is sufficiently tight and resistant to the liquid being handled?

1.2.2.1 Is the floor under flexible in-plant pipelines leaktight?

❒ Yes ❒ No ❒ Not applicable

1.2.2.2 Is the floor is resistant to possible pressure?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Repair of leaking portion of pipe and sealing material.
- Repair or replacement of fittings and sealing material.

Medium-term measures:

- Pressure and leakage tests.
- Alternative measure: non-destructive testing method such as random ultrasonic scanning of wall thickness.
- Provide necessary tight secondary containment.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=140

2 Dimensioning of pipelines and demonstration of tightness

2.1 Were the physical and chemical properties of the substances handled properly taken into consideration when planning the pipelines?

❒ Yes ❒ No ❒ Not applicable

2.2 Is there any document on how the maximum permitted overpressure was sized?

❒ Yes ❒ No ❒ Not applicable

2.3 Was the tightness of all pipes demonstrated before commissioning by an approved testing method and the results of the test documented?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

2.3.1 Have the results been documented?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Testing of special pipe fittings (T'-joints, connecting sleeves) or specific valves and fittings with regard to the required design pressure.
- Ultrasonic scanning of the walls of selected pipe fittings to ascertain the available wall thickness (random test) and calculation of the adequate wall thickness.

Medium-term measures:

- Pressure and tightness tests to demonstrate that the pipes are tight.
  Test medium: **Water**.
  Test pressure: 1.3 x maximum operating overpressure of the pipe.
  Test medium: **Nitrogen or air** (precautionary measures are necessary).
  Test pressure: 1.1 x maximum operating overpressure of the pipe.
- If the test can not be performed for safety reasons: Non-destructive tests, e.g. measuring of the wall thickness with ultrasonic method at representative sections of the pipeline could be an alternative.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	Partially	No
❒	❒	❒
RC=1	RC=5	RC=10

3 Suitability and durability

3.1 In regard to the purpose they are intended for, the pipes must be adequately resistant to water-polluting substances and durable to:

a) Mechanical stresses?

❒ Yes ❒ No ❒ Not applicable

b) Thermal stresses?

❒ Yes ❒ No ❒ Not applicable

c) Chemical stresses?

❒ Yes ❒ No ❒ Not applicable

d) Biological stresses?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Testing of special pipe fittings (T'-joints, connecting sleeves, sealing) or specific valves and fittings with regard to the required design pressure.
- Ultrasonic scanning of the walls of selected pipe fittings to ascertain the available wall thickness (random test) and calculation of the adequate wall thickness.
- Visual inspection of the inner walling of selected pipe sections (e.g. by dismantling a fitting).
- Checking of available pipe documentation.
- *Medium-term measures:*
- Pressure and tightness tests.
  Test medium: **Water**.

Test pressure: 1.3 x maximum operating overpressure of the pipe.
Test medium: **Nitrogen or air** (precautionary measures are necessary).
Test pressure: 1.1 x maximum operating overpressure of the pipe.

- If the test can not be performed for safety reasons: Non-destructive tests, e.g. measuring of the wall thickness with ultrasonic method at representative sections of the pipeline could be an alternative.

Long-term measures:

- Record the suitability and resistance of all pipes based on the results of the test and positive operating experience in the pipeline documentation.
- New installations: A demonstration of the suitability and resistance should be performed by the installer or manufacturer prior to the installation.

Determination of the real risk
Is the sub-point of the recommendation implemented?

Yes	Partially	No
❒	❒	❒
RC=1	RC=50	RC=100

4 Drifting and Inclination

4.1 Can the safety or tightness of the pipe be impaired or affected by any drift in position (e.g. resulting from thermal expansion) or inclination (e.g. resulting from the sinking of the support structures)?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:

- Check the correct position of defined fixed points.
- Check the layout of the support structures.
- Proof that the length compensation for a possible thermal expansion is adequate.

Medium-term measures:

- Improve the support structures.
- Installation of expansion compensators or change the layout of the piping to ensure sufficient expansion space.

Determination of the real risk
Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=100

5 Risk of mechanical damage

5.1 Has the pipeline been installed in such a way that the risk of mechanical damage, e.g. as a result of being hit by vehicles and other mechanical impacts (e.g. from cranes, excavators, conveyor) can be ruled out?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Installation of such barrier as protection if there is a direct danger of being bumped by vehicles or other mechanical damage:
  - crash barrier consisting of steel beam or similar constructions.
  - Installation of bollards made of steel or concrete.
  - Construction of concrete walls.
  - Piling up of earth dams.

Medium-term measures:

- Installation of adequate protective barriers (as mentioned under "short-term measures").

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=100

6 Recurrent inspections by experts

6.1 Is the tightness of the pipelines being checked by experts at regular intervals?

❒ Yes ❒ No ❒ Not applicable

6.2 Is the resistance to corrosion of the pipelines being checked by experts at regular intervals?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Tightness and resistance to corrosion tests should be conducted by external experts (if possible).
- Identification of the scope of testing required.

Medium-term measures:

- The required tests should be performed by recognised experts.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	Partially	No
❒	❒	❒
RC=1	RC=5	RC=10

7 Resistance of pipeline to corrosion

7.1 If the risk of corrosion of the pipelines can not be ruled out, then the rate of reduction of the wall thickness in-between two checks should be determined.

7.1.1 Is this rate of reduction known?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

7.1.2 Is the determination of the rate of reduction carried out?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

7.2 The reduction of the wall thickness due to corrosion may lead to inadmissible reduction of the pipeline static.

7.2.1. Is there any proof to show that a reduction of the pipeline static can be ruled out?

❒ Yes (proof is available) ❒ No (proof is not available) ❒ Not applicable

7.2.1 Have there been in the past any actions undertaken to remove reduction of the pipeline static?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Determination of the rate of reduction of the wall thickness by gauging the wall thickness with Ultrasonic method at various representative portion of the pipeline at defined intervals.
- Computer evaluation of the results to establish whether there is a possibility of inadmissible reduction of the pipeline static as a result of the identified reduction in the wall thickness due to corrosion.

Medium-term measures:

- Recurrent checks for corrosion at defined and representative portion of the pipelines (setting up a test program).

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

8 Resistance and coatings

If the piping material is not sufficiently resistant, suitable coatings of the inner walls or other equivalent safety measures are required.

8.1 Are the inner walls of the pipeline coated (for example with rubber, enamel, thermoplastics such as PE-HD or PTFE, laminates)?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

8.2 Have other equivalent safety measures been taken (e.g. laying the pipes above the ground within containment with liquid-tight surface)

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Large scale wall thickness gauging (checking schedule).

Medium-term measures:

- Construct a liquid-tight surface with containment below the pipeline at critical points or along the whole length of the pipeline.

Long-term measures:

- Laying the pipes above the ground in protective tubes with the lowest point ending in a collecting pit in which the operating staff or leakage sensors can identify leakages.
- Installation of piping made of corrosion-resistant materials.
- Coat the inner layer of the pipeline or cover them with material which is resistant to corrosion.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

9 Layout of pipeline piping arrangement

9.1 Are the pipeline installed in such a way that they can not be affected by danger resulting from nebouring facilities and other units?

❒ Yes ❒ No ❒ Not applicable

9.2 Are the pipeline installed in such a way that they can not endanger neighbouring facilities and other units?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Identification of potential dangers and risks resulting from neighbouring facilities and units.

- Checking of critical layout with regard to neighbouring pipelines (crossings, parallel lines).

Medium-term measures:

- Protective measures against the effects of fire or explosion:
  - Earth dams
  - installing particular sections of pipeline beneath the ground surface
  - Protective walls
  - Protective tubes.

Long-term measures:

- Ensure the minimum gap between pipes at crossing points.
- Ensure adequate safety gaps or install the pipeline beneath the ground surface where there is a danger of fire or explosion.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

10 Specific safety measures

10.1 Is there a risk of electrostatic charges due to the properties of the media being transported?

❒ Yes → 10.2 ❒ No→ 11 ❒ Not applicable

10.2 Have adequate technical safety measures been taken to prevent electrostatic charging?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

10.3. Are the technical safety measures to prevent electrostatic charging controlled regularly?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- To remove static electricity.
- Regular inspections over removal of static electricity.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

11 Underground pipeline

❒ relevant ❒ not relevant→ 12

11.1 Do underground pipes exist?

❒ Yes→ 11.2 ❒ No→ 12 ❒ Not applicable

11.2 Are the underground pipeline designed as follows?

❒ Double-walled pipes; leakages in the walls are automatically indicated by an approved leakage indicator.

❒ Pipeline is designed as suction pipe; the liquid column will be interrupted in case of leakages through the walls of the pipeline.

❒ Installation of Pipeline in a protective tube or duct; spilled substances can be detected in an inspection chamber.

❒ Other technical design due to security reasons, which is equivalent to the above mentioned.

Brief description:

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Pressure and tightness tests of single wall pipeline which are installed beneath the ground surface.
- Estimation of the durability with the aid of an approved testing method and computational evaluation to show if the static is no longer adequate (see section 2).

Medium-term measures:

- Replacement of single-walled pipeline installed beneath the ground surface by new ones installed above the ground.

Long-term measures:

- Design and install underground pipes in a way to allow automatic detection of leakage and automatic alarm.

Example: preparation and assessment of the durability of single wall pipelines installed under the ground

Preparation of Pipelines for wall thickness gauging

Taking sample

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	Partially	No
❒	❒	❒
RC=1	RC=70	RC=140

12 Planning, installation and operation of pipelines

12.1 Are the documents for planning and execution of pipeline installations available?

❒ Yes ❒ No ❒ Not applicable

12.2 Are the documents for the pressure and tightness tests performed before the commissioning of the unit available?

❒ Yes ❒ No ❒ Not applicable

12.3 Are the documents on regular checks of the pipelines available (visual control over the pipeline by users)?

❒ Yes ❒ No ❒ Not applicable

12.4 Is it guaranteed that installation works on the pipelines are performed by skilled technical staff?

❒ Yes ❒ No ❒ Not applicable

12.5 Are all maintenance work and modification on the pipelines documented?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

12.6 Are the changes in pipelines documented?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Medium-term measures:

- Laying down procedural rules regarding the piping documentation:
  - New installations, extensions and replacement of pipeline as well as their fittings should documented in writing.
- Pressure and tightness tests should be performed prior to commissioning of pipelines. Their results should be documented with the following details:
  - Duration and date of testing.
  - Object of testing, test medium, pressure and duration.
  - Results of test.
- Documentation on the scheduled regular checks of all piping, including the scope of such checks, e.g.:
  - Visual inspection of the tightness of detachable joints, exterior corrosion.
  - Technical testing of safety installations (testing their efficiency).
  - Condition and tightness of sealed surfaces and containments.
  - Documentation of all maintenance work, to include the following details:
  - executing department or contractor
  - Type and character of the maintenance work performed
  - Shut-down and start-up procedures / signal for start-up.

Long-term measures:

- Compilation of a pipe work documentation that includes all relevant documents of the pipelines.

Determination of the real risk
Is the sub-point of the recommendation implemented?

Yes	Partially	No
❒	❒	❒
RC=1	RC=5	RC=10

13 Labeling or marking of the pipelines

13.1 Are the pipelines labelled in accordance with the physical and chemical properties of the substances they handle?

❒ Yes ❒ No ❒ Not applicable
❒ Action ❒ No action

13.2 Is the direction of stream/flow marked on the pipelines?

❒ Yes ❒ No ❒ Not applicable
❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measure:
- Labelling the pipelines according to applicable regulations.

Medium-term measures:
- Adequate labelling of the pipelines according to the applicable regulations, taking the physical and chemical properties and the direction of flow into consideration, with:
  - Paint: painting a ring round the pipe with a particular colour

or
  - Paint: painting the pipeline completely with a particular colour
  - using adhesive labelling strips.

Determination of the real risk
Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

14 Pipeline layout

14.1 Are there plans and documents that show the position and direction of relevant pipelines?

❒ Yes ❒ No ❒ Not applicable
❒ Action ❒ No action

Remarks:

Examples of actions:
Long-term measures:
- Indication of the site and position of relevant pipelines in a proper pipeline layout.

- Include the pipeline layout in the documentation for the pipelines.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

Summery of the Checklist

Sub-point of the Recommendation	Possible Risk category	Risk categories
1	1 / 140	
2	1 / 5 / 10	
3	1 / 50 / 100	
4	1 / 100	
5	1 / 100	
6	1 / 5 / 10	
7	1 / 10	
8	1 / 10	
9	1 / 10	
10	1 / 100	
11	1 / 70 / 140	
12	1 / 5 / 10	
13	1 / 10	
14	1 / 10	

Average **R**isk of the **C**hecklist **(ARC)**