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

№ 11

Industrial plant in areas with a risk of flooding

For our Environment

Umwelt Bundesamt

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Industrial plant in areas with a risk of flooding

by

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Recommendations of the International River Basin commission on the requirements for industrial plants handling water-polluting substances in areas with a risk of flooding

Area of application: The requirements apply to plant, plant components (including pipelines) and safety systems which could be affected by flooding. It does not matter whether the flooding is caused by high tide, static water or from the sewage system, rise in the level of groundwater due to persistent case of flooding or fire-fighting water of retaining systems for fire fighting water. The requirements apply equally to new as well as existing plants.

1. Underground plant units

1.1. Underground containers and pipelines should be secured against the force of buoyancy, e.g. through:
- Increasing the height of covering earth,
- Covering the container with concrete slabs or
- Anchoring with steel band fixed in a concrete slab.

1.2. The security of underground containers and pipelines against the force of buoyancy must be established to be about 1.3 times that of the security of an empty container against the force of buoyancy in regard to a totally flooded container.

1.3. Underground container and pipeline must be able to withstand the pressure exerted by the water due to flooding, which means they must be designed to withstand such stress statically. This must be proved with a producer's certificate.

2. Outdoor over-ground plant unit

2.1. Container and plant unit must be protected against the force of buoyancy and from mechanical damages due to floating substances and similar objects.

2.2. The containers and plant units must not hinder the free flow of the floodwater.

2.3. The lower bottom edge of the containers must be above the water level that is equal to a recurrence interval of about HQ_{100}[1)].

2.4. Pipelines should be laid in such a way that they are above the water level corresponding to a recurrence interval of about HQ_{100}.

3. Over-ground plant units in buildings

3.1. Containers should be installed in such a way that they are secured against the force of buoyancy. The security against the force of buoyancy can be achieved through e.g.:
- Anchoring with steel bands fixed on the ground,
- Anchoring with steel bands fixed on side walls,
- Supporting with steel braces fixed on the roof of the storage rooms.

3.2. The ground, side walls and the roof of the storage rooms must be able to withstand the force of buoyancy. This should be assessed by a stress analyst.

3.3. If the containers are installed in a coated secondary containment, anchoring on the coatings should be avoided. If this can not be avoided, ensure that the sealing within the coated surfaces are perfectly executed.

3.4. If the containers are secured against the force of buoyancy with an anchor fixed to the side walls or roof of the storage room, ensure that a rotating motion of the container is not possible.

3.5. The security of underground plant units inside buildings against the force of buoyancy must be established to be at least 1.3 times that of the security of an empty container against the force of buoyancy in regard to a totally flooded container.

[1)] *Flooding with a recurrence interval of hundred years*

3.6. Container must be able to withstand the pressure exerted by the water due to flooding that means they must be designed to withstand such stress statically. This must be proved with a producer's certificate.

4. Plant units

4.1. Venting pipes must be installed in such a way that their open end can not be flooded. They should be secured with anchors along the whole length and installed in such a way that they can not be damaged by the pressure of the water or floating objects. In the case of extension of the venting pipe, the specialised company executing the job should establish whether the containers are designed to statically withstand internal pressure that could occur due to any overfilling of the container. If the venting pipes have to be installed higher than permissible (e.g. for containers having a test overpressure of about 0,3 bar, the venting pipe must be installed more than 3 m above the bottom of the container), then a solution for such cases is necessary (e.g. using containers having a higher permissible test overpressure). Shut-off devices are not allowed for venting pipes.

4.2. Filling ports should be closed with a seal if they can be flooded. The sealing is only allowed to be removed during filling procedures.

4.3. Pipelines (Filling, connecting and discharging pipelines) should be anchored along the whole length and installed in such a way that they can not be damaged.

4.4. All openings of the containers and pipelines should be installed in such a way that they are water-proofed, if the risk of their being flooded can not be ruled out.

- The dome cover should be sealed by a professional firm and must be safe from flooding. The tightening of the screws will not remedy for carelessly placed seals (for example if they are placed overlapping each other). The tightness must be proven with a producer's certificate.
- Dome cover without screws must be fixed in such a way that they can not be shifted by stream of water during flooding. Additional screws are required in case of a doubt.
- In the case of a level gauge made of plastic casing and mounted directly on top of the container (the so called floating equipment), it can be assumed that sufficient tightness can not be guaranteed. Such appliances should be dismantled if a total flooding of the container is possible and the port closed with a plug. Alternative to this is to install a pneumatic level gauge.

Checklist for monitoring the implementation of the recommendations

Overview of the risk of flooding

Is there a risk of flooding at the site of the existing plant or a plant in planning due to:

- High water?

❒ Yes ❒ No ❒ Not applicable

- Back pressure from the waters or canals?

❒ Yes ❒ No ❒ Not applicable

- Increase in the level of groundwater as a result of prolonged period of high water?

❒ Yes ❒ No ❒ Not applicable

- Fire-fighting water contained in the containment devices?

❒ Yes ❒ No ❒ Not applicable

Remarks:

1. Underground storage systems

❒ relevant ❒ not relevant→ 2

1.1. Are the underground vessels and pipelines secured against the force of buoyancy?

❒ Yes ❒ No → 2 ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

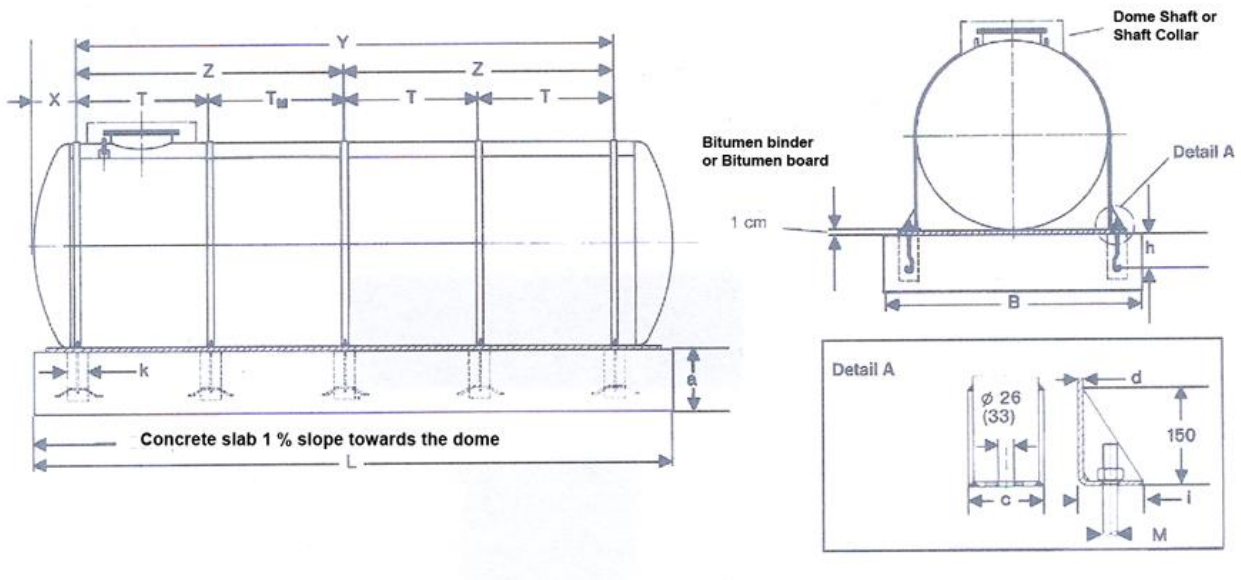
Short-term measures:

- The following measures are necessary if the underground vessels or pipelines are not sufficiently secured against the force of buoyancy:
  - cover them with more earth, or
  - cover the vessels with concrete slabs, or
  - anchor them with steel bands which are secured in a concrete slab (see the picture).

Long-term measures:

- When underground storage systems are built, underground components should be secured by anchoring with steel bands which are secured in a concrete foundation(see the picture

Safety device against the force of buoyancy on an underground double shell steel tank



Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=100

1.2. Has the security against the force of buoyancy been proven to be at least 1,3 times that of

the security of an empty container against the force of buoyancy (in regard to a totally flooded container)?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- *Establish the sufficiency of the security against the force of buoyancy.*

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

Yes	No
❒	❒
RC=1	RC=10

1.3. Is it guaranteed that the vessels and pipelines can withstand the external water pressure, i.e. were the components statically designed for such conditions?

❒ Yes ❒ No → 2 ❒ Not applicable

❒ Action ❒ No action

1.4. Has the manufacturer certified that the equipment can withstand the effects of a flood?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- If written proof is not available from the manufacturer, a sort of simplified calculations can be made by the company.

Long-term measures:
- If the statical safety can not be proven, affected plant components or units must be replaced or installed in such a way that they are out of the danger zone.

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

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

2. Outdoors over-ground storage systems

❒ relevant ❒ not relevant → 3

2.1. Are the reservoirs and plant components protected against flush?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

2.1. Are the vessels and plant components secured against the force of buoyancy and mechanical damages from floating or similar objects?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Long-term measures:
- Provide protective devices for the vessels and plant components, e.g.:
  - Steel grids,
  - Steel supports,
  - Protective walls,
  - Earth walls or similar constructions.

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

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

2.2. Has it been ensured that the vessels and plant components do not hinder the drainage of flood water?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Long-term measures:
- The vessels and plant components should be installed outside the danger zone.
- If possible, high water can also be kept away from the plant by constructing earth walls.

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

Yes	No
❒	❒
RC=1	RC=10

2.3. Does the local authority have documentation on the water level for a recurrence interval of HQ_{100}?

Note: The HQ_{100} means indicator of water level in a reservoir, which is by statistical data is achieved or exceeded once in 100 years

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

2.3.1. Has it been ensured that the bottom edge of each vessel is above the water level corresponding to a recurrence interval of HQ_{100}?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- To obtain corresponding information from competent authorities on the water level situation for a recurrence interval of HQ_{100}.

Medium-term measures / Long-term measures:

- Install the vessel at a location where it can be guaranteed that the water level situation for a recurrence interval of HQ_{100} is below the lower edge of the vessel.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

2.4. Has it been established that pipelines are installed above the water level for a recurrence interval of HQ_{100}?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Medium-term measures / Long-term measures:

- Install the pipelines in a way that the water level situation for a recurrence interval of HQ_{100} is below the lower edge of the pipeline.

Determination of the real risk

Is the sub-point of the recommendation implemented?

Yes	No
❒	❒
RC=1	RC=10

3. Aboveground storage systems within buildings

❒ relevant ❒ not relevant → 4

3.1. Are the vessels installed in such a way that they are secured against the force of buoyancy?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Medium-term measures:
- Secure the vessels and plant components against the force of buoyancy with additional measures, e.g.:
  - Anchoring with steel bands fixed at the foundation or on the side walls,
  - Support with steel braces fixed to the ceiling of the storage room.

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

Yes	No
❒	❒
RC=1	RC=100

3.2. Are the floor, side walls or ceiling of the storage room constructed to withstand the force of buoyancy?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

3.2.1. Is there any assessment from a stress analyst available?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- The required assessment should be done by a stress analyst.

Long-term measures:
- If it can not be proven that the floor, side walls or ceiling of the storage room can withstand the forces of buoyancy, the statically relevant components should be constructed accordingly.

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

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

3.3. Are the vessels installed in coated secondary containments?

❒ Yes ❒ No ❒ Not applicable

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

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

3.4. Is it possible to avoid the use of anchors within the coated surface of the containment?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

3.4.1. Are the anchors within the coated surface carefully sealed?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- Use readily available materials to seal the penetrations on the coated surfaces.

Medium-term measures:
- Use appropriate sealing material and suitable methods for sealing the penetrations.

3.4.2. Are containers which are secured against the force of buoyancy with anchors fixed to the side walls or supported against the ceiling also secured against rotation?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

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

Yes	No
❒	❒
RC=1	RC=10

3.5. Has the security against the force of buoyancy been proven to be at least 1.3 times that of the security of an empty container against the force of buoyancy (in regard to a totally flooded container)?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

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

Yes	No
❒	❒
RC=1	RC=10

3.6. Is it guaranteed that the vessels can withstand the external water pressure, i.e. were the components statically designed for such conditions?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

3.6.1. Has the manufacturer certified that the equipment can withstand the effects of a flood?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- If written proof is not available from the manufacturer, a sort of simplified calculations can be made by the company.
- Request written proof from the manufacturer or the builder of the plant.

Long-term measures:
- If the static safety can not be proven, affected plant components or units must be replaced or installed in such a way that they are out of the danger zone.

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

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

4. Plant components

❒ relevant ❒ not relevant → 5

4.1. Were the open ends of venting pipes secured from flooding?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- *Increase the length of venting pipes in such a way that their open ends can not be flooded.*

Determination of the real risk

Is the sub-point of the recommendation implemented?

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

4.1.1. Are the venting pipes fixed firmly along their entire length?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

4.1.2. Are the venting pipes fixed with anchors over the entire length and installed in such a way that they cannot be damaged by external water pressure or by floating objects?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

4.1.3. After increasing the length of venting pipes, has it been checked by a professional firm to determine whether the vessels are designed to statically withstand the internal pressure occurring due to overfilling?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- It must be proven by means of calculation that the vessels are designed to withstand the internal pressure due to overfilling of the vessels.

4.1.4. Are suitable measures taken, if in case of overfilling of the vessels due to the height of the venting pipes, the permissible statically internal pressure of the vessel is exceeded?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- Train and instruct the personnel to check the measuring instruments regularly and to respond promptly if there is a risk of overfilling.

Medium-term measures:

- Provide technical measures to limit the maximum pressure (e.g. install a rupture disk) and ensure that the admissible static internal pressure of the vessel is not exceeded. The Liquid released as a result of the response of the rupture disc must be discharged safely.

4.1.5. Were the venting pipes installed without shut-off valves?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:
Short-term measures:
- All shut-off devices in the venting systems must be dismantled.

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

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

4.2. Are all filling ports sealed with gaskets against flooding?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

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

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

4.3. Are all pipelines (filling, connection and drainage pipelines) fixed with anchors over the entire length and installed in a way that they can not be damaged?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

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

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

4.4. Are all openings of the vessels and pipes which could be flooded installed in a way that they can not flooded?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

4.4.1. Was the sealing of the dome cover executed to resist the effects of flooding by a professional firm?

❒ Yes ❒ No→ 4.4.3 ❒ Not applicable

❒ Action ❒ No action

4.4.2.Is the tightness of the dome cover certified by a professional firm?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- If the tightness of the seal can not be certified by the professional firm, the seals should be replaced by the firm.

4.4.3. Is the dome cover without screws fixed in such a way that they can not be shifted by the water current in case of flooding?

❒ Yes ❒ No ❒ Not applicable

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- In case of doubt, fix the dome cover with additional bolts.

4.4.4. Are level gauges made of plastic casing mounted directly on top of the vessels (so-called floating gauges)?

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

❒ Action ❒ No action

Remarks:

Examples of actions:

Short-term measures:

- If there is a risk of being flooded, the level gauges should be removed and close the ports on the vessel tightly with a stopper. As alternative replace the floating gauges with pneumatic level gauges.

Determination of the real risk

Is the sub-point of the recommendation implemented?

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

Summery of the Checklist

Sub-point of the Recommendation	Possible Risk category	Risk categories
1.1	1 / 100	
1.2	1 / 10	
1.3	1 / 5 / 10	
2.1	1 / 50 / 100	
2.2	1 / 10	
2.3	1 / 10	
2.4	1 / 10	
3.1	1 / 100	
3.2	1 / 5 / 10	
3.3	1 / 5 / 10	
3.4	1 / 10	
3.5	1 / 10	
3.6	1 / 5 / 10	
4.1	1 / 5 / 10	
4.2	1 / 5 / 10	
4.3	1 / 5 / 10	
4.4	1 / 5 / 10	

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