

# An Integrated Risk Assessment Methodology for Wastewater Treatment Plants

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## THE PROBLEM:

The urban wastewater treatment plants (WWTP) involve several risks with internal and external consequences that the management entities must consider to eliminate or minimize the accident occurrences. By this reason, system managers need to have methodologies that allow, in an objective way and at any moment, an understanding of the risks that are associated with the WWTP functioning and evaluate the vulnerabilities of their targets.



## GOAL:

- To develop a methodology that gives to the WWTP managers an easy to use and flexible tool to identify:
  - The global risk level (GRL) associated with the WWTP functioning;
  - The main risk factors that contribute to this GRL;
  - The main WWTP works sites that contribute to this GRL.

## SCOPE:

- Risk scenarios with implications to:
  - Safety targets;
  - Human health targets;
  - Socio-economic targets;
  - Environmental targets.

Existing methodologies and tools:

- Environmental and public health risk assessment ([1], [2], [3], [5]);
- Voluntary standards (ISO 14001:2004, OSHAS 18001:2007, ISO 24511:2007, ISO CD 31000:2009 and UNE 150008EX).

None of these frameworks or methodologies gives an integrated risk analysis that consider simultaneously the safety, human health, socio-economic and environmental consequences of a harmful occurrence in WWTP.

## THE METHODOLOGY



RISK LEVEL FOR EACH SCENARIO [6]

$$NR_i = [(f_p \cdot \log(P) + f_s \cdot \log(S) + f_e \cdot \log(E) + f_c \cdot \log(C)) / (f_p + f_s + f_e + f_c) \cdot \log(5)] \cdot 99 + 1$$

GLOBAL RISK LEVEL

$$GRL = NR_i$$

P - Probability index  
S - Severity index  
E - Exposition index  
C - Safety conditions

$f_p$  - Probability weighting factor  
 $f_s$  - Severity weighting factor  
 $f_e$  - Exposition weighting factor  
 $f_c$  - Safety weighting factor

We assumed:  
 $f_p = f_s = f_e = f_c = 1$   
P, S, E and C classified between 1 to 5 (expert evaluation)

Risk factor code (Accordingly to the scope)	NR <sub>i</sub> value		Risk Classification
	%	integer	
	0-22	1	Very low
	23-44	2	Low
	45-69	3	Moderate
	70-86	4	High
	87-100	5	Very High

## INFORMATION SOURCES

- Installations auditing and inquests;
- Databases consultation;
- Material safety datasheets consultation;
- Environmental monitoring reports;
- Technical reports on European, national and regional plans context;
- Inventories of natural and human patrimony values.

## CASE STUDIES

- Conventional treatment system with activated sludge process.
- Advanced high load physicochemical treatment.
- Sludge digester
- Odour treatment and biogas exploitation.
- Discharge by a submarine outfall into Cantabrian Sea.

- Conventional treatment system with activated sludge process.
- Discharge over a stream course near Atlantic beaches.



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## RISK MAP OF ONE WWTP



- With a GRL of 60%, this WWTP has a moderate risk;
- Risk factor with major meaning: Infrastructures damage (PE3), with very high risk
- High risk factors:
  - The non compliance of the discharges and environmental quality thresholds (PA13 and PA14);
  - The population exposition to infectious agents (PS1);
  - The noise (PF6);
  - The atmospheric contamination with odoriferous agents and toxic gases (PA10 and PA11);
  - Skin contact with chemical agents (PQ2).
- Works site with major risk: Gases treatment (LG1), classified as high risk site.
- Risk factor/works site pair with special attention: Structures damage by sludge transport (PE3/LS10), corresponds to a very high risk scenario.

## THE OTHER TWO WWTP

- Also have a moderate global risk level, with GRL values of 49% and 57%.

- The risk factors and the works sites with major values of risk level are summarized in the table above:

	WWTP 1	WWTP 2
Major risk factors	<ul style="list-style-type: none"> <li>• Noise;</li> <li>• Hazardous atmospheres with air contamination, low oxygen concentrations and high air humidity and temperature.</li> </ul>	<ul style="list-style-type: none"> <li>• Noise;</li> <li>• Skin contact with chemical agents;</li> <li>• Hazardous atmospheres with air contamination, low oxygen concentrations and high air humidity and temperature;</li> <li>• Odorous gases liberation;</li> <li>• Infrastructures damage.</li> </ul>
Works sites with higher risks	<ul style="list-style-type: none"> <li>• Pre-treatment works.</li> </ul>	<ul style="list-style-type: none"> <li>• Pre-treatment works and activated sludge treatment.</li> </ul>

- The noise in one WWTP was classified as very high risk;
- The other risk factors are classified as high risk;
- The pre-treatment works in one WWTP was classified as high risk site;
- The other ones as moderate risk sites.

✓ Through the presented methodology it was possible to calculate the Global Risk Levels of the studied WWTP.

✓ Additionally, it was easily to identify what risk factors contributes to these GRL and what works sites need a special attention.

✓ With this tool, the system managers can easily make decisions to minimise the risks and to improve their safety, human health, socio-economic and environmental performance.

## References

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