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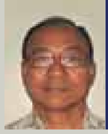


# Quantitative Analysis of EIA for **Environmental Engineers**

## BACKGROUND

Many environmental impact assessment (EIA) reports are lacking in science and technology, in that they contain more description than scientific calculation. EIA reports, which are vital tools for decision-makers, involve specialised studies in specialised fields, many of which are based on environmental engineering.

According to Brockman (2009), "The main business of engineering is to apply technology in concert with natural phenomena to develop these things that we need or want. Whereas the natural sciences traditionally seek to discover how things *are*, engineering focuses on the question, 'What form *should* we give to this thing so that it will effectively serve its purpose?'

"Most engineering problems are *open-ended*, in that they don't have a single solution. Engineering approaches are based on:

- how to represent a design problem
- how to make assumptions
- how to generate possible ideas for designs
- how to effectively conduct a search for a solution
- how to plan and schedule activities
- how to make efficient use of resources
- how to organise the components and activities of a team design project."

Based on the above-mentioned approaches, EIAs prepared by environmental engineers are supported by calculations. This is the main difference between EIAs written by environmental engineers and EIAs written by environmental scientists.

Nowadays most project owners/managers are willing to cooperate with EIA specialists from the planning stage to avoid EIA-recommended alterations at a later stage.

## THE ENVIRONMENTAL IMPACT ASSESSMENT

An EIA report consists of:

- Baseline data (existing environment such as air, water, noise, community, infrastructure)
- Project data
- Impact prediction, i.e. above-mentioned two items combined
- Mitigation measures, and
- Monitoring programme.

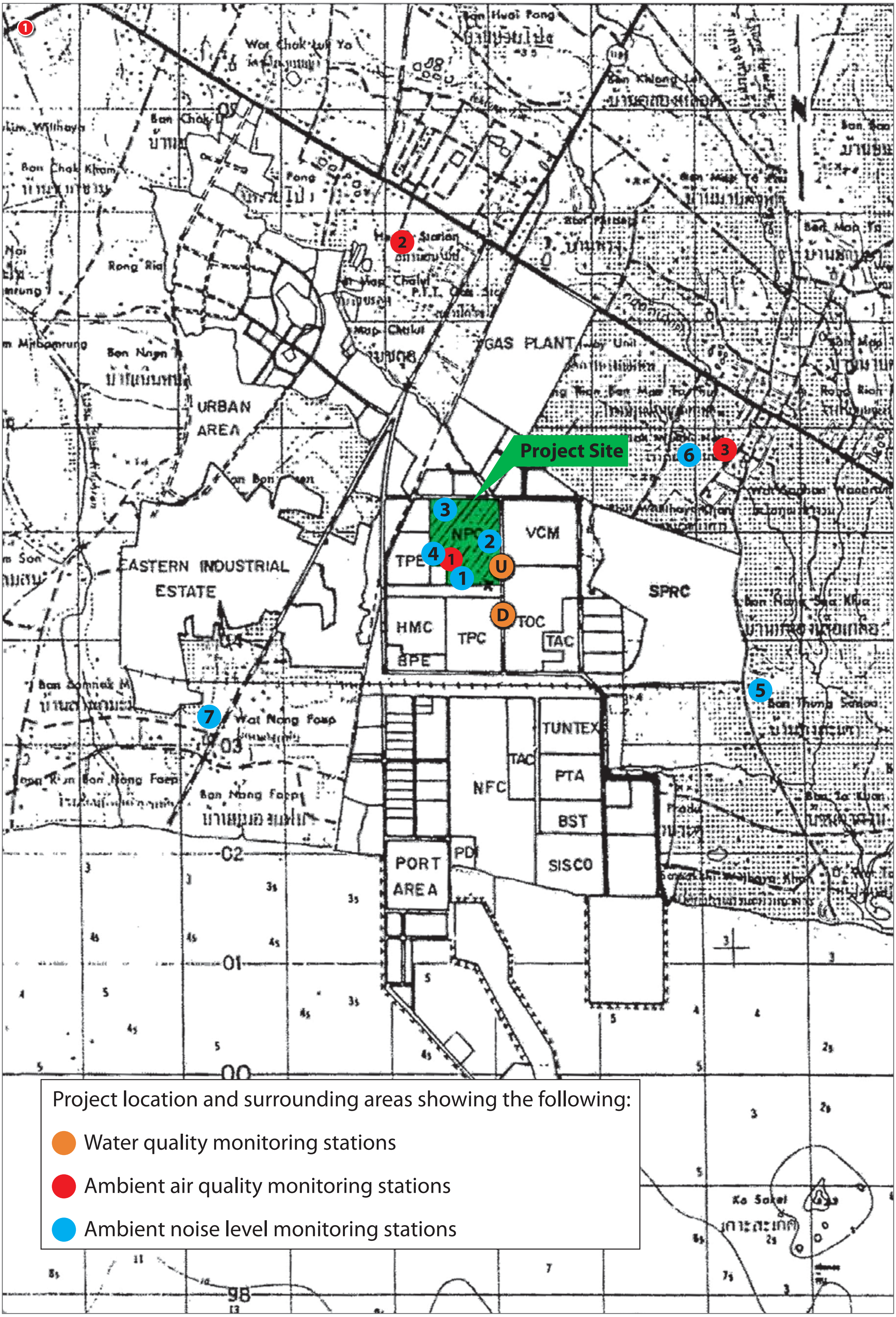
Firstly, a project plan indicating the location of the project site and surrounding areas is given to the EIA specialist. It is the responsibility of the EIA specialist to then check the existing main drainage system, and the drainage system of the proposed project, as well as to estimate the increased future stormwater runoff.

The Rational method is used to estimate the quantity of runoff in the project area:

$$Q = CIA$$

where
Q is the maximum flow
C is the coefficient of runoff areas
I is the average rainfall intensity, and
A is the drainage area.

Then the sizes of the drains are checked to determine whether they can accommodate increased flow or not. For this step: read the site map, and find out the size of the main drain and its direction.




Project location and surrounding areas showing the following:

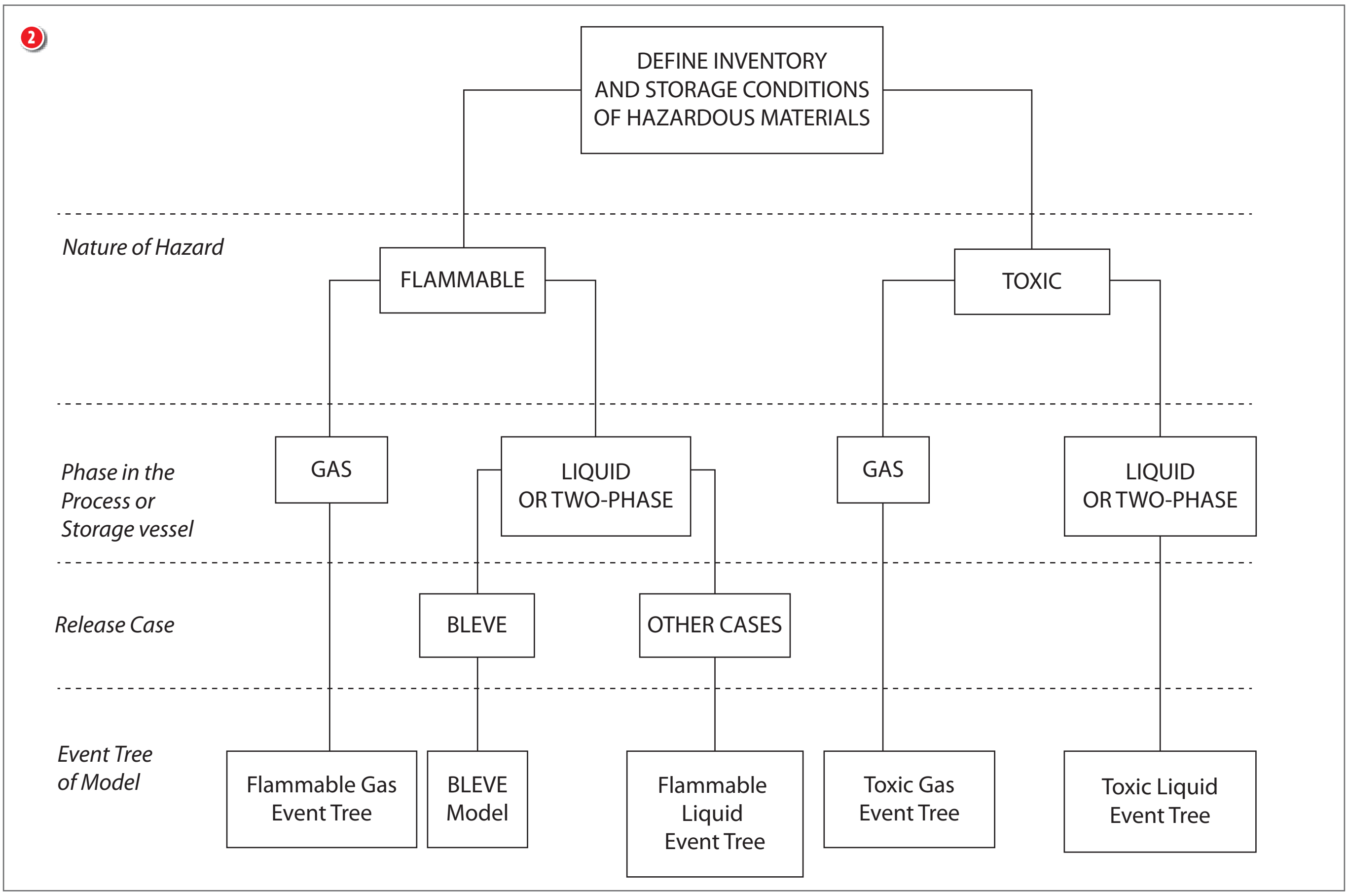
- Water quality monitoring stations
- Ambient air quality monitoring stations
- Ambient noise level monitoring stations

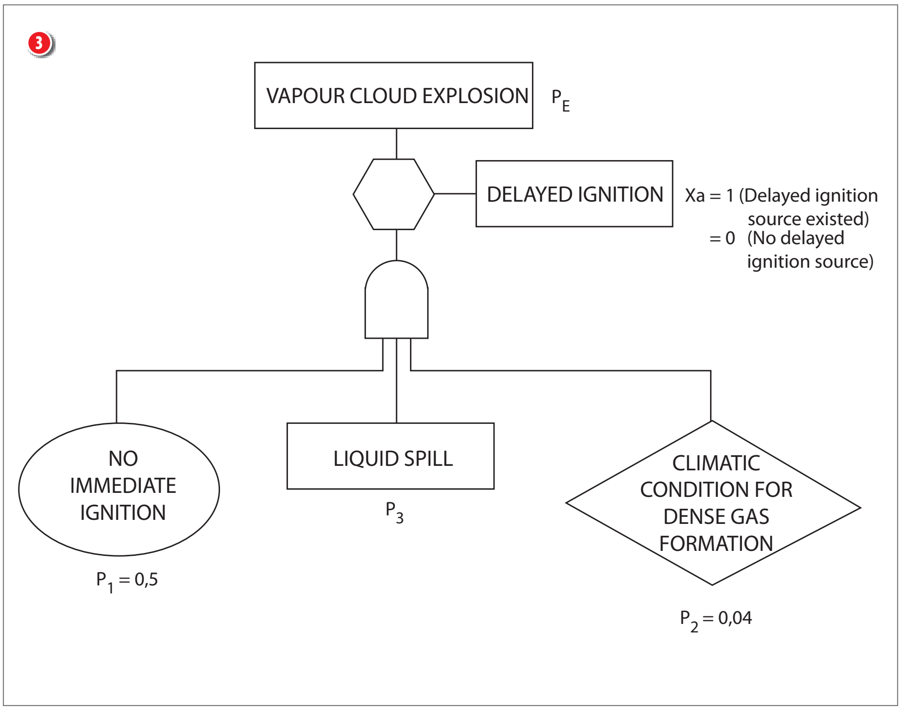
The velocity of flow and the size of the drains are checked by using continuity equation $Q = Av$ and the Manning formula $v = (1/n)\, m^{2/3} s^{1/2}$ where "v" is the flow velocity, "n" is the Manning's roughness factor, "m" is the hydraulic mean depth and "s" is the bed slope.

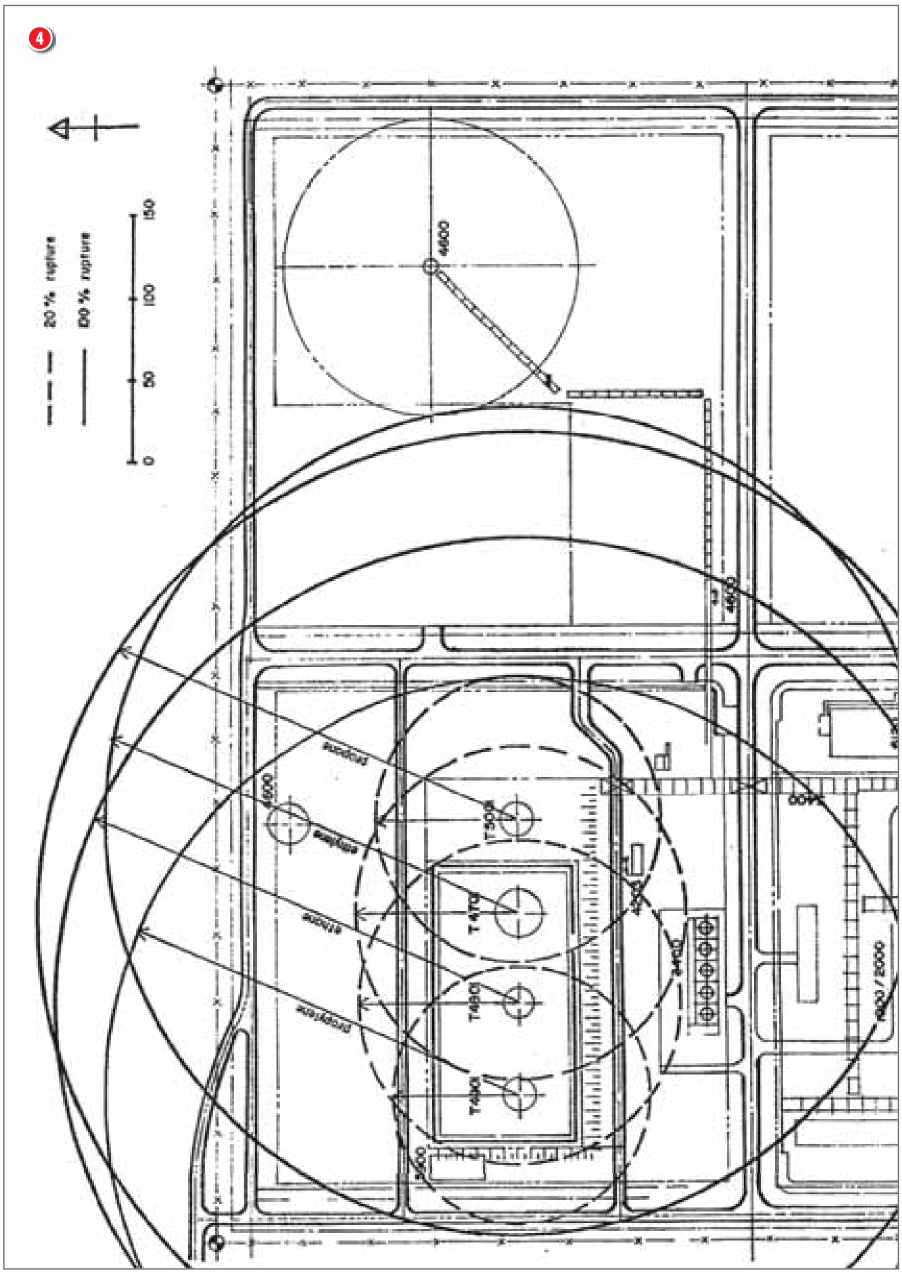
1 Project location and surrounding areas

2 Failure case definition tree

Using the project detail drawing and P&ID diagram, determine the mass balance of all inputs and all outputs. All inputs are energy (power, steam, fuel, compressed air), water and raw materials. All outputs are solid waste, liquid waste, gaseous waste, noise, products and by-products. This entails drawing material balance sheets based on the chemical process diagrams. Check the water demand for the project (including processing and cooling tower if necessary) and calculate the percentage demand for the project based on the existing usage of the surrounding areas.






## CALCULATIONS AND PROBLEMS ENCOUNTERED

### Water pollution impact

The quality of the receiving water course can be affected by the treated wastewater discharged from the project. One of the main tasks of the EIA specialist is therefore to analyse the effluent to check the removal efficiency.

Use the equation:

$$\text{Removal Efficiency (\%)} = \frac{\text{Influent C} - \text{Effluent C}}{\text{Influent C}} \times 100$$

and check the removal efficiency of each unit in the proposed wastewater treatment plant for SS, COD, BOD, $NO_3^-$ and $Cl^-$, etc. Then compare the quality of the final effluent with the standard set by the governing body.

It is necessary to estimate the impact of effluent on the receiving water course. First locate the outlet pipe of the project at the water course. Then take water samplings at the outlet location, 50 m before and 50 m after the outlet. Next, calculate the impact on the constituents (BOD, COD, phenol, grease and oil, SS, $NO_3^-$, etc) in the receiving water by using the Mass Balance equation:

$$C_{mix} = \frac{Q_{water} C_{water} + Q_{eff} C_{eff}}{Q_{water} + Q_{eff}}$$

### Air pollution impact

To estimate gas emission from the project, extract the gas emission from the mass balance sheets of the project description. The type of gas and concentration, emission temperature, stack height, stack diameter and emission velocity are determined from the project data sheets. At the beginning of the EIA project, the existing air quality is measured ($SO_2$, $NO_3$, $CO_2$, TSP, etc). Use the above-mentioned gas emission data as input data and run air modelling (e.g. ISCST/LT) to predict the ground level concentration. The modelling results are shown by isopleths. Also check the air quality at the receptors (the most vulnerable places are schools, hospitals, clinics and community centres). Then compare the results with the ambient air criteria.

### Noise pollution impact

High-level noise-producing areas should be identified and, using the compounding effect of the noise level, its impact to the nearest community should be calculated by using the following equation:

$$L_{p2} = L_{p1} - 20 \log (R2/R1)$$

where Lp1 and Lp2 are noise levels at R1 and R2 distances.

Then the composite noise level (ambient + noise from project) is calculated by:

$$Lp\ total = 10 \log (1/n) (\Sigma\ 10^{Li/10})$$

#### Fire and explosion impact

This concerns only catastrophic failure – fatality and property damage. First, based on the storage inventory, high pressure, temperature and fire /explosion index, identify hazardous substances / process areas. The analysis of the potential hazard is recorded by using the HAZOP study and fault tree diagram. Then the probability of each hazard is calculated, and its consequences (e.g. fire and/or explosion) analysed by using a hazard model such as WHAZAN. The hazard impact is then shown on the project area and its surrounding by different impact intensities.

#### Fire prevention and safety

Based on locations and the number of fire hydrants, the fire prevention areas are checked together with water pressure and water storage demand.

## CONCLUSION

EIAs for industrial projects are challenging and require engineering science and technology – hydraulics and hydrology, water and wastewater engineering, building engineering, pipeline engineering, water pollution analysis, drawing interpretation, chemical process engineering, air modelling, and hazard modelling. All these applications prove that the EIA is pertinent to environmental engineers.

## REFERENCES

1. Brochman, J B 2009. *Introduction to Engineering: Modelling and Problem Solving*. John Wiley & Sons Inc.
2. Final Report, Environmental Impact Assessment of Olefins Plant (Expansion), Map Ta Phut, Rayoung, Thailand, 1996. ◻

3 Fault tree diagram for unconfined vapour cloud explosion

4 Boundary of hazard consequences from vapour cloud explosion

*EIAs for industrial projects are challenging and require engineering science and technology – hydraulics and hydrology, water and wastewater engineering, building engineering, pipeline engineering, water pollution analysis, drawing interpretation, chemical process engineering, air modelling, and hazard modelling*



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