# FACILITY DESIGN REQUIREMENTS

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## Contents



## Summary

Sustainable development requires the incorporation of pollution prevention principles in both facility design and permits to operate them. When designing a facility one should adopt the appropriate methods of environmental management, as well as clean technologies for both production and processes. Best Available Techniques (BAT) are efficient tools for implementing the principles of pollution prevention. They are also strongly related to stricter emission limit values and constitute a substantial parameter for Integrated Pollution Prevention and Control systems.

## 1. The meaning of clean production and the principle of pollution prevention

### 1.1 Clean production

Enormous growth of the human population and of industrial activities has been causing the release of substantial amounts of pollutants into the biosphere, which is consequently being degraded, with serious implications for both the environment and human health. The relentless increase in environmental pollution in recent decades has forced humankind to look for effective ways and means for alleviating this growing problem.

In a nutshell, in the last few decades strategies for pollution prevention have passed through the following stages: disposal of pollutants without any control into the environmental media; dispersion of pollutants into the environment; and application of end-of-pipe technologies.

Pollution prevention efforts finally came to the point where today it takes place at source (or should do so), thus leading to the concept of what is called 'clean production' which is indeed a practical way of moving towards sustainable development. For it allows the production of goods and services using smaller quantities of raw materials and energy than would be the case otherwise, and reduces both waste generated and environmental impacts. Indeed, clean production is the step beyond pollution management, because it deals with the source of the problem rather than the symptoms.

Clean production is not a new concept, however. It is a logical extension of our desire to conserve materials and reduce pollution. It requires people to examine what they do and to look for better, less polluting and more efficient ways of doing what they do—ways that result in increased productivity, reduced resource inputs and reduced pollution, and, most importantly, reduced environmental impacts and risks.

The methods of cleaner production are dynamic. Although industry has significantly improved its environmental performance over the last two decades or so, there is still much room for improvement. Wider adoption of clean (or cleaner) production methods by industry and business is expected to bring bigger financial profits as well as greater environmental protection and welfare.

The basic philosophy of clean production is concerned with the conservation of raw materials and energy, elimination of toxic raw materials, and reduction (ideally minimization) of the quantity and toxicity of all emissions and wastes before they leave the production facility. Clean production requires the application of know-how, less polluting technologies and processes, and, perhaps most importantly, a friendlier attitude to nature and the environment. Terms such as eco-efficiency, pollution prevention, waste minimization and source reduction that are in use today refer directly or indirectly to clean production, or stem from it. Thus, cleaner production covers all processes, products and services and their impacts including design and the use of raw materials and energy. It covers all wastes, including hazardous and toxic wastes, whether emitted into the air or water, or released to land.

### 1.2 Pollution prevention

Increasingly both permitting strategies and legislation are focusing on internationally accepted principles that are central to sustainable development. One of these principles is the 'principle of pollution prevention'. That is, prevention of pollution at source, which is now a strategic element of environmental policy-making. Similarly, the concept of resource productivity is increasingly being used in both environmental policy-making and activities. This concept establishes a strong linkage between policy-making on one hand, and the importance of the ecology-ecology relationship on the other. Pollution prevention strategies and clean technologies implemented during production processes have an increasingly important role in industrial production. Pollution prevention at source not only results in pollution reduction, which is of course very desirable, but also brings savings on raw materials and energy. Production costs are reduced as a result.

## 2. Aspects affecting the design of a facility

### 2.1 Pollution prevention strategy

Pollution Prevention Strategy is a hierarchically organised tool for improving a specific production process, or a production unit of a facility. This strategy generally comprises the following four steps:

Step 1: *Process design:* designing or re-designing the production process without substituting for toxic materials at this stage.

Step 2: *Minimizing process residues:* possible reductions in the use of materials, or substitution of materials, are identified and implemented as appropriate; for example, improved sequencing of the process steps, regeneration of chemical solutions, recuperative rinsing, etc.

Step 3: *Reuse:* production with or without the reuse of process residues.

Step 4: *Process design:* design of the process so that the residue streams become by-product streams; all outputs from a process are designed for optimum values right from the beginning.

Consider, for example, the case of the metal and electroplating industry. In accordance with the pollution prevention strategy, the following options are presented in a hierarchical way:

- First, improvement options for investigating the need for cleaning followed by options for the application of the least harmful cleansing materials.
- Options for the optimisation of the cleaning process and good housekeeping.
- Options for the optimisation of on-site and off-site recycling.

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## Biographical Sketches

**Mr. Alexendros Karavanas** received his Diploma in Chemical Engineering from the National Technical University of Athens, Greece, in 1977, followed by a degree in Pharmacology from the University of Athens in 1991.

Currently Mr. Karavanas is working for the Ministry of Environment, Physical Planning & Public Works, Athens, where he is responsible for Environmental Permitting. This involves environmental impact study of industries, granting environmental conditions and permits, corresponding EU legislation, as well as European Community's Support Framework for the Environment. His main duties and tasks include environmental impact assessment of industrial facilities (examination, authorization, setting of environmental conditions especially for the food, pharmaceutical and pesticide industries, tanneries, textile industries, chemical industries etc.).

He has represented the Greek Ministry of Environment (1997-2001) on the European Community's Committee on article 19 of Directive 96/61, "Integrated Pollution Prevention and Control (IPPC)", concerning the inventory of the IPPC industries, as well as on the European IPPC Bureau's Technical Working Group for Food and Milk, Seville, Spain. To date he has participated in several projects of the Greek Ministry of Environment concerning emission inventory of industrial sources in Greece, and implementation of the IPPC system and Best Available Techniques for industry. He has addressed several seminars organized by, among others, the National Technical University of Athens and the University of Athens on environmental issues including environmental impact statement, treatment of waste water effluents, air emissions, pollution control equipment, and impacts from the operation of the food, textile, and chemical industries.

**Dr. Michael Christolis** is a Civil Engineer specializing in environmental science and technology. Currently he is working as a research collaborator at the National Technical University of Athens (NTUA), Greece, on the mathematical modeling of environmental problems. He has so far accumulated twenty years of experience in air quality monitoring, pollutant dispersion modeling, assessment of the impacts of industrial accidents, design of emergency systems, and implementation of the Seveso Directive in Greece.

During 1983-1988 he was the Head of the Laboratory for the Air Quality Monitoring Network for the City of Athens. In 1988 he joined the Computational Fluid Dynamics Unit (CFDU) of the Chemical Engineering Department of the NTUA, working on research projects on the computational modeling of various applications focusing on environmental issues and problems.

**Professor Nicholas C. Markatos** obtained his Diploma in Chemical Engineering from the National Technical University of Athens, Greece, in 1967, followed by M.Sc, DIC and Ph.D degrees from the Imperial College of Science, Technology & Medicine, University of London, UK, during 1970 to 1974.

In 1983 Professor Markatos was appointed Director of the Centre for Mathematical Modeling and Process Analysis at the school of Mathematics and Scientific Computing of the University of Greenwich, London, England. At that time he was also a visiting lecturer to the Computational Fluid Dynamics Unit of Imperial College as well as working for CHAM Ltd, (Concentration Heat and Momentum, Limited), London, England. At CHAM he worked first as leader of the Aerospace Group (1976) and then, from 1977 until 1984, as Manager of the Applications Team working on various Fluid Mechanical, Thermodynamic and Transport problems.

Since 1974 he has served as technical consultant to many Research Centres, state institutions and industries.

In June 1980 he was awarded the "Certificate of Recognition" by the Inventions Council of NASA.

In 1985 Professor Markatos was elected Professor of Chemical Engineering at the National Technical University of Athens, and in 1990 he was elected Head of the Chemical Engineering Department. In 1991 he was elected Rector of that University.

Professor Markatos' main scientific interest is in the mathematical modeling of Transport Phenomena, Fluid Mechanics, Thermodynamics and Physical Processes like Fluid Flow (Laminar and especially Turbulent), Heat and Mass Transfer, Environmental Flows, Combustion, etc.

He is referee of scientific papers, reviewer of new books, as well as member of the Editorial Board of several international Scientific Journals.

He has published over 100 original scientific papers in international journals and participated and organized many international conferences, seminars and meetings all over the world. Author of two books, he has also published many articles in the popular press on Engineering Higher Education.