

# **NUCLEAR REACTOR PROCESS SYSTEMS:**

## **THERMALHYDRAULIC DESIGN**

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February 1996**

for the Thailand Initiative

## FOREWORD

The nuclear reactor is a fine example of technology and of the art of reason. In fact, all of our present technology owes its existence largely to the powers of reason. Aristotle, generally regarded as the forefather of reason, would have been proud. The precise formulation of concepts in the form of mathematics and logic form the language upon which technology relies. So overwhelming has the progress of reason been, that the world outside reason has all but disappeared in our language, our thoughts, our actions. Yet, as important as reason has been in providing the motive power behind technology, that motive power would have been applied without direction were it not for that small vestige beyond reason that still remains in humans. This small vestige, though suppressed almost to the point of extinction in Western society, remains powerful as the guiding light for the train of thought.

That guiding light is quality, for lack of a better word. What does insisting on quality mean? How does one insist on quality? The only route I know is to question everything. By questioning, knowledge (facts) is gained. But much more importantly, wisdom is gained by the process or the act of questioning.

So, with this in mind, one can begin to appreciate what this manual represents and how it should be used. This is more than a manual on how to design nuclear process systems. It is a manual on why the systems should be designed that way in order to form the philosophical basis for design. Words, however, cannot do justice to philosophy. Thus, this manual can, at best, give the roots of the knowledge required for a deeper understanding of the design and the design process. This manual can only form the basis for an individual's understanding and act as a springboard to the goal: wisdom of the design process.

Thus, the study of the process of process design begins: a process whose final outcome, the operating reactor, is best viewed as the tail-light of the caboose on the train of thought which is guided by the wisdom of the individual designers, by the quality of their decisions. A not incidental side effect is actually the effect for the individual. The pursuit of quality, the growth of wisdom in the individual is the key to the individual and to a meaningful co-existence with this environment, of which reactors are but a part.

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## GLOSSARY OF ABBREVIATIONS AND ACRONYMS

<b>AE</b>	Acoustic Emission
<b>AECB</b>	Atomic Energy Control Board
<b>AESOP</b>	Atomic Energy Simulation of Optimization (computer code)
<b>ASDV</b>	Atmospheric Steam Discharge Valve
<b>ASSERT</b>	Advanced Solution of Subchannel Equations in Reactor Thermalhydraulics (computer code)
<b>ASTM</b>	American Society for Testing Materials
<b>BLC</b>	Boiler Level Control
<b>BLW</b>	Boiling Light Water
<b>BPC</b>	Boiler Pressure Controller
<b>CCP</b>	Critical Channel Power
<b>CHF</b>	Critical Heat Flux
<b>CPR</b>	Critical Power Ratio
<b>CRL</b>	Chalk River Laboratories
<b>CRT</b>	Cathode Ray Tube
<b>CSA</b>	Canadian Standards Association
<b>CSDV</b>	Condenser Steam Discharge Valve
<b>CSNI</b>	Canadian Standards for the Nuclear Industry
<b>DBE</b>	Design Base Earthquake
<b>DCC</b>	Digital Control Computer
<b>DF-ET</b>	Drift Flux-Equal Temperature
<b>DF-UT</b>	Drift Flux-Unequal Temperature
<b>DNB</b>	Departure from Nucleate Boiling
<b>ECC</b>	Emergency Core Cooling
<b>ECI</b>	Emergency Core Injection
<b>EFPH</b>	Effective Full Power Hours
<b>EVET</b>	Equal Velocity Equal Temperature
<b>EVUT</b>	Equal Velocity-Unequal Temperature
<b>EWS</b>	Emergency Water Supply
<b>FBR</b>	Feed, Bleed and Relief
<b>FP</b>	Full Power
<b>HEM</b>	Homogeneous Equilibrium Model
<b>HTS</b>	Heat Transport System
<b>HWP</b>	Heavy Water Plant
<b>HYDNA</b>	Hydraulic Network Analysis (computer code)
<b>I&amp;C</b>	Instrumentation and Control
<b>IBIF</b>	Intermittent Buoyancy Induced Flow
<b>ICRP</b>	International Commission on Radiological Protection
<b>LOC</b>	Loss of Coolant
<b>LOCA</b>	Loss of Coolant Accident
<b>LOC/LOECC</b>	Loss of Coolant with Coincident Loss of Emergency Core Cooling
<b>LOP</b>	Loss of Pumping
<b>LOR</b>	Loss of Regulation
<b>MCCR</b>	Ministry of Corporate and Consumer Relations



<b>MCS</b>	Maintenance Cooling System
<b>MHD</b>	Magneto hydrodynamics
<b>milli-k</b>	Unit of reactivity for reactor physics
<b>NPD</b>	Nuclear Power Demonstration
<b>NPSH</b>	Net Positive Suction Head
<b>NUCIRC</b>	Nuclear Circuits (computer code)
<b>OECD</b>	Organization for Economic Co-operation & Development
<b>PGSA</b>	Pickering Generating Station A
<b>PHTS</b>	Primary Heat Transport System
<b>PHW</b>	Pressurized Heavy Water
<b>PHWR</b>	Pressurized Heavy Water Reactor
<b>PRESCON2</b>	Pressure Containment (computer code)
<b>QA</b>	Quality Assurance
<b>RAMA</b>	Reactor Analysis Implicit Algorithm
<b>R&amp;M</b>	Reliability and Maintainability
<b>RB</b>	Reactor Building
<b>rem</b>	röntgen or rad equivalent mammal or man?
<b>RIH</b>	Reactor Inlet Header
<b>ROH</b>	Reactor Outlet Header
<b>RTD</b>	Resistance Temperature Detectors
<b>SDM</b>	Safety Design Matrices
<b>SOPHT</b>	Simulation of Primary Heat Transport (computer code)
<b>SRV</b>	Safety Relief Valve
<b>TMI</b>	Three Mile Island
<b>TOFFEA</b>	Two Fluid Flow Equation Analysis (computer code)
<b>UVUT</b>	Unequal Velocity Unequal Temperature
<b>VB</b>	Vacuum Building
<b>VC</b>	Vacuum Chamber
<b>WRE</b>	Whiteshell Research Establishment