# The Real-Time Behavior of the Steam-Boiler

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**Abstract**

This paper presents a rigorous model of the dynamics of the physical process of the steam-boiler and of the embedding of the discrete program given in [TLTSol] in the continuous environment. Program constants and variables are clearly distinguished from physical quantities, and it is shown, that under some conditions the program variables approximate the physical quantities. This relation between physical and program variables is technically speaking, a *coupling invariant*. Hybrid and real-time aspects of the system are also considered, including several positive and negative results regarding the expected properties of the system. Some of them are *impossibility* results, independent of the particular controller program chosen.

This paper illustrates a simple method for combining different abstraction levels in the design and verification of industrial control programs. Programs are specified by their next-state relation (in first order logic) without real-time (but, if needed, using program clocks). The behavior of the environment is described by the physical laws that govern the dynamics of the process. Those two levels are bridged together by the specification of the deadlines that the implementation has to guarantee.