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Analysis of the Techno-economic Implications Generated by the Selection of Manufacturing Codes of Pressure Vessels for High Demanding Applications

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Abstract

The selection of the manufacturing code in components for high demanding applications is crucial. A new methodology is developed to solve the problem of manufacturing codes selection. This methodology allows to obtain an integrated approach that considers a technical evaluation that consists of quantifying the stringency of technological requirements together with an economic study. By the implementation of the new methodology, an alternative that combines the benefits of both standards from a multi-criteria perspective based on functional and economic criteria has been proposed. This proposal represents a saving of 5.8% with respect to the use of KTA standards, without diminishing of technical stringency.

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Keywords: Manufacturing code; selection; pressure vessel; nuclear industry; high-demanding applications.

1. Introduction

A manufacturing code is a set of standards, specifications, design formulas and criteria applied to the design, manufacture, installation, inspection, and certification of any industrial component. Manufacturing codes are usually

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published by international organizations of recognized prestige in the field of standardization. The oldest organization is the American Society of Mechanical Engineers (ASME), founded in the late nineteenth century [1]. This American Society publishes the Boiler and Pressure Vessels (B&PV) Code [2], that it is widely used in the design of reactor pressure vessels for the nuclear industry. Other international manufacturing codes are the RCC-MR code [3] in France and the KTA rules [4] in Germany [5]. The selection of the manufacturing code of components for high demanding applications is crucial. Therefore, in this work, a new methodology is developed to solve the problem of manufacturing codes selection. This methodology allows to obtain an integrated approach that considers a technical evaluation that consists of quantifying the stringency of technological requirements [6] together with an economic study. Pressure vessels manufacturing for nuclear industry has been chosen as a case study and, particularly, ASME B&PV and KTA codes have been selected for this study according to the regulation of the Spanish nuclear power plants.

Nomenclature

ASME B&PV	American society of mechanical engineers boiler and pressure vessels
KTA	Kerntechnischer Ausschuss (German nuclear commission)
C_R	Relative cost (Value Analysis Method)
L_e	Experimental limit (method of Stringency Levels)
L_s	Standardized limit (method of Stringency Levels)
$L_{s\ (Min)}$	Minimum value of the Standardized limits (method of Stringency Levels)
$L_{s\ (Max)}$	Maximum value of the Standardized limits (method of Stringency Levels)
SL	Stringency Level
$SL_{(Max)}$	Maximum value of Stringency Level according to the defined scale
SL_R	Relative Stringency Level (Value analysis method)
UTS	Ultimate Tensile Strength
VAM	Value Analysis Method
Y_p	Yield Point

2. Methodology

The methodology (Fig.1) is developed through a combination of a stringency level evaluation [6] with the value analysis method [7].

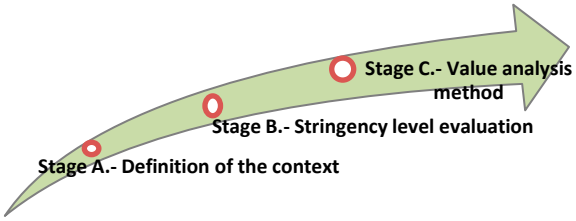

Fig. 1. Methodology description.

The novel approach allows to assess the technological requirements together with the economic impact generated by the manufacturing codes selection from an integrative point of view. Once the context is defined (Stage A), the calculations are performed (Stages B and C).

2.1. Stage A.- Definition of the context

At present, regulations on nuclear and radiological safety tend to be homogenized in all countries of the world, but they do not reach the same legal formulation, since this is a matter for national parliaments. This means that there are still serious differences in the nuclear regulations of some countries and therefore in the technological requirements for the manufacture of main components, which are due to the historical vicissitudes experienced since