A COMPARISON OF DIFFERENT IMPORTANCE MEASURE FOR MULTISTATE SYSTEMS

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Importance measures have been mainly applied to systems made up of binary elements (i.e., elements that can be in two states: functioning or faulty). This kind of systems has many practical applications. Yet, the hypothesis of dichotomising the elements and system states is often over-simplified and insufficient for describing the real functioning of many systems, such as, for example, power generation systems [1-3] and gas and oil transportation systems [4]. The performance of such systems can settle on different levels (e.g. 100%, 80%, 50% of the nominal capacity), depending on the operative conditions of the constitutive multi-state elements. Systems characterized by different levels of performance are referred to as Multi-State Systems (MSS).

Efforts are being made to evaluate the importance of elements of multi-state systems. Early progress towards the extension of the Birnbaum measure to the case of multi-state systems can be found in [5], for the case of finitely many states, and in [6], for the case of continuum structure functions. More recently, the Birnbaum measure has been extended to the case of multi-state systems composed by binary elements [7] and to the case of elements with dual failures-modes [8].

Importance measures related to the occupancy of a given state by an element have been proposed in [5] and [9]: these measures characterize the importance of a given element being in a certain state or degrading to the neighbouring state with respect to the expected system performance. The IM of a given element is, therefore, represented by a vector of values, one for each state of the element. Such representation may be of difficult interpretation to the practical reliability analyst. Recently, some of the authors have proposed a generalization of some commonly used importance measures for application to multi-state systems constituted by multi-state elements [10]. Physically, these measures characterize the importance for a multi-state element of achieving a given level of performance and their definitions entail evaluating the system availability and/or performance when the functioning of the element of interest is restricted in performance.

The present paper analyzes in details the above mentioned MSS importance measures and compares them from the analytical and physical viewpoints. As a result of the analysis, it will be shown that all the measures can be derived from the approach proposed in [9], with significant reduction in the computational burden. This is verified on a simple case study of literature.

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