MinMax choice of inspection program of fatigue-prone airplane structure

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Probability of failure (PF) of fatigue-prone aircraft (AC) and failure rate (FR) of airline (AL) for specific inspection program can be calculated using Markov Chains (MC) and Semi-Markov process (SMP) theory if parameters of corresponding models are known. Exponential approximation of fatigue crack size growth function $a(t)=a_0\exp(Qt)$, where a_0, Q are random variables, is used. Estimation of the parameters of distribution function of these variables and the choice of final inspection program under condition of limitation of PF and FR can be made using results of observation of some random fatigue crack in full-scale fatigue test of the airframe. For processing of acceptance type test, when redesign of new aircraft should be made if some reliability requirements are not met, the MinMax decision is used.The process of operation of AC is considered as absorbing MC with (n+4) states. The states $E_1,E_2,...,E_{n+4}$ correspond to AC operation in time intervals $[t_0,t_1),[t_1,t_2),...,[t_n,t_{SL})$, where is an inspection number, is specified life (SL), i. e. AC retirement time. States E_{n+2},E_{n+4} and E_{n+4} are absorbing states: AC is descarded from service when the SL is reached or fatigue failure (FF) or fatigue crack detection (CD) take place. In corresponding matrix for operation process of AL the states E_{n+2},E_{n+4} and E_{n+4} are not absorbing but correspond to return of MC to state E_1 (AL operation returns to first interval) and the gain of this process, g, are calculated using the theory of SMP with reword, taking into accout the reword of succesful operation in one time unit, the cost of acquisition of new AC after SL, FF or CD take place. The problem of inspection planning is the choice of the sequance $\{t_1,t_2,...,t_n,t_{SL}\}$ corresponding to maximum of gain under limitation of AC intensity of fatigue failure. In numerical example the minimax decision, based on observation of some fatigue crack during acceptance full-scale fatigue test of airframe, is considered.

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