This paper presents an investigation of how to model the statistical properties of radio channels arising in industrial environments over long time horizons, e.g., hours and days. Based on extensive measurement campaigns, conducted at three different factory buildings, it is shown that for mobile transceivers the fading characteristics are Rayleigh or close to Rayleigh. However, for transceivers mounted at fixed locations, the use of conventional single fading distributions is not sufficient. It is shown that a suitable model structure for describing the fading properties of the radio channels, as measured by power, is a mixture of gamma and compound gamma-lognormal distributions. Furthermore, the complexity of the model generally increases with the observation interval. A model selection approach based on a connection between Kullback's mean discrimination information and the log-likelihood provides a robust choice of model structure. We show that while a (semi)-Markov chain constitute a suitable model for the channel dynamics the time dependence of the data can be neglected in the estimation of the parameters of the mixture distributions. Neglecting the time dependence in the data leads to a more efficient parametrization. Moreover, it is shown that the considered class of mixture distributions is identifiable for both continuous and quantized data under certain conditions and under those conditions a maximum likelihood under independence assumption estimator is shown to give consistent parameters also for data which are not independent. The parameter estimates are obtained by maximizing the log likelihood using a genetic and a local interior point algorithm.