Biopharmaceutical products are emerging within the pharmaceutical industry. However, biopharmaceuticals are often unstable in aqueous solution. Freeze-drying (lyophilisation) is the preferred method to achieve a stable product with an increased shelf-life. During batch freeze-drying, there are only two adaptable process variables, i.e. the shelf temperature and the pressure in the drying chamber. The value of both should be optimized, preferably in a dynamic way, to minimise the primary drying time while respecting process and equipment constraints and ensuring end product quality. A mechanistic model is used to determine the optimal values for the adaptable variables, hereby accounting for the uncertainty in all involved model parameters. A dynamic Design Space was constructed with a risk of failure acceptance level of 0.01%, i.e. a 'zero-failure' situation. Even for a risk of failure of 0.01%, the computed settings resulted in a reduction of the drying time by over 50% compared to current practice.