In this work we performed Geant4/GRAS calculations for the eva- luation of dose reduction to astronauts, in case of exposure to a SPE, using different models of a radiation protection spacesuit. An average radiation environment was simulated with the ESP model. After dedi- cated 1D simulations to evaluate the ranking of different materials in terms of shielding properties, combinations of best performing mate- rials have been adopted in the design of spacesuit models. The results of the 1D simulation phase can be summarized as fol- lows: (i) for a fixed volume, materials with high density (Aluminum and Nextel 312) provide more shielding but they have a higher mass (2 The mathematical phantom of GRAS has then been exposed to the chosen SPE radiation environment, both in the scenario of EVA (phantom in free space) and IVA (phantom inside a typical aluminum module). For the two scenarios, dose values to BFO in Gy-Eq were de- rived for the phantom with/without the proposed spacesuit models, whose design was based on a selective shielding strategy. It is important to note that presented results are not to be intended as generally valid, as they depend on several factors: the choice of the specific model for the SPE environment; the choice of the phantom and the definition of BFO; the Al thickness chosen to represent a typical space module for IVA activities. However, the main results of this work are given in terms of percentage of dose reduction (therefore independent on specific characteristics of the SPE event as its fluence) and, taken all together, they point to the validity of the proposed personal shielding strategy. As already mentioned, results for EVA are to be considered as purely in- dicative, in that no realistic description of an EVA suit is adopted for simulations. Such results simply point to the additional protection which could be offered to astronauts during EVA in case of SPE, if the concept of wearable shielding were to be adopted and implemented in existing suit models. Dose reductions to BFO from 44 to 57% are shown to be achievable during IVA with the proposed spacesuit designs, the highest value being reached for the multilayer spacesuit model with HDPE and water. Suit elements have a thickness in the range 2–6 cm and the total mass for the garment sums up to 35–43 kg. Dose reduc- tions have been converted in time gain, e.g. the increase of time delay between the occurrence of a SPE and the time the dose limit to BFO to prevent the onset of symptoms of radiation sickness is reached: for the best performing suit the gain is more than 100% in the IVA scenario, meaning that the astronaut has more than double of the time (e.g. 5.9 instead of 2.5 h) to perform emergency operations outside a radiation shelter in case of a SPE when wearing the suit. The mass (and hence cost) saving potential thanks to the shielding provided by the suits during IVA has also been calculated, considering the amount of mass that would need to be added to the module used to simulate the IVA scenario to provide the same additional shielding given by the suit. To achieve an average dose reduction of 50%, this is equal to about 2.5 tons Al. Overall, the results of this design study for a wearable radiation protection spacesuit offer a proof-of-principle validation of a com- plementary personal shielding strategy in emergency situations in case of a SPE event. By wearing a radiation protection spacesuit that reduces the dose to sensitive organs, thus delaying the onset of radiation effects, an astronaut could spend a longer time in the habitat but outside a radiation shelter during a SPE, taking care of all possible necessary actions. Concerning the possible use for EVA, realistic elements of current spacesuits (such as oxygen supply and propulsion systems) should be added in the calculations to draw any conclusion, but the proposed shielding strategy can possibly be implemented or applied also to existing EVA spacesuit models. Most importantly, the best 77 M. Vuolo, G. Baiocco et al. Life Sciences in Space Research 15 (2017) 69–78 performing spacesuit design we propose is based on the use of protec- tion elements filled with water, a necessary resource in present and future space habitats. This implies that a potential prototype for a spacesuit following the guidelines from this feasibility study can be realized to be filled at need with drinking water, and also to be later drained after use in order to avoid any water waste. Results presented in this work lead the way for the design and realization of a water-filled spacesuit prototype (funded by the Italian Space Agency - ASI), to be tested in terms of wearability on board the International Space Station (ISS), in the framework of the next NASA-ASI long-duration mission. For the realization of the prototype, a spacesuit design will have to be optimized following wearability and comfort criteria for the astronaut and safety requirements for use in the ISS environment. A successful outcome of the test on board the ISS, together with dedicated simula- tions and measurements of the spacesuit radiation shielding perfor- mances for different SPE environments, will provide important progress in the field, leading to the further refininement of the design of radia- tion protection spacesuits and their possible adoption in future long- duration manned .missions in deep space