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Control of dust production in ITER (P3-J-94)

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In the last years dust has been observed in a number of fusion devices and is being studied more in detail for understanding in particular the physical phenomena related to its formation, its composition, physical and chemical characteristics, and the amount of produced dust. The extrapolation of dust formation to ITER predicts (with large error bars), a large mass of dust production with a scattered size distribution. To evaluate the impact of dust on safety, assumptions have also been made on radionuclide inventory, and mobility in off-normal events, as well as any postulated contributions the dust may make to effluents or accidental releases.
Solid activation products in structures are generally not readily mobilisable in incidental and accidental situations, so that activated dust, tritium and activated corrosions products are the important in-vessel source terms in postulated scenarios that assume a mobilisation and release of some fraction of this inventory. Such a release would require the simultaneous leak or bypass of several robust confinement barriers. Further concerns for dust may be the potential for chemical reactions between dust and coolant in the event of an in-vessel leak, and the theoretical possibility of a dust explosion, either of which could in principle cause a pressure rise that challenges one or more of the confinement barriers. Although these hazards can – and will – be controlled by other measures in the ITER design, application of the principle of Defence in Depth dictates that the dust inventory should also be minimised and controlled to prevent the potential hazard.
A well-coordinated R&D programme is required to support this dust production control. This document provides from the safety point of view, an overview of existing data given in "Dossier d'Options de Sûreté", the first safety report presented in 2001 to the French Safety Authorities, and ITER documents; it also gathers information on status of studies on activated dust, as well as production, transport, localisation, detection and cleaning studies, which are in a research phase mainly in Europe and USA. It is also pointed out that dust production itself is a study to be performed in ITER and that validation by R&D of simulation codes relevant from the safety point of view needs to be deepened. The strategy and needs for future R&D on dust production, transport and characterisation, diagnostics for production control, cleaning systems, and evaluation of dust risk explosion is discussed.