Safety by Processes Design for Manufacturing Hazardous Nanomaterials

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Industrial production of nanomaterials exposes workers to risks that arise not only from the chemical composition of these materials, but also from their shape, size, degree of aggregation, and surface chemistry. Control Banding is a tool used in big production plants for managing these risks. It is based on the definition of levels (i.e., bands) of hazard (i.e., toxicity of the nanomaterials) and exposure (i.e., probability to come in contact with or penetrate into the human body during production), and on the elaboration, for each band, of controls, which include technical, administrative, and behavioral protocols. In big plants, however, production processes cannot be changed easily, and Control Banding is used mainly as a process to minimize risks. In this work, we show, instead, that Control Banding can be used not only to manage, but also to design safe processes of production of potentially toxic nanomaterials in pilot plants that operate at a pre-commercial level. We analyze the risks and elaborate controls for the production of textiles coated with antibacterial nanoparticles (i.e., Ga@C-dots, ZnxCu1-xO, ZnO, CuO, SiO2@TiO2, PPy) for three processes implemented in three experimental plants—partners in the EU project PROTECT (GA N. 720851): 1) continuous roll-to-roll sonochemical synthesis and deposition for production of antibacterial textiles, 2) continuous roll-to-roll spray coating for upholstery fabrics, and 3) batch sonochemical synthesis and deposition of nanoparticles for antibacterial products and devices.

In this study we will demonstrate how Control Banding makes it possible to prioritize risks derived from the exposure of workers to nanomaterials and how this tool becomes strategic to design safe, future mass production processes.

Probability of Exposure

Severity of Hazard	Extremely Unlikely (0-25)	Less Likely (26-50)	Likely (51-75)	Probable (76-100)
Very High (76-100)	RL 3	RL 3	RL 4	RL 4
High (51-75)	RL 2	RL 2	RL 3	RL 4
Medium (26-50)	RL 1	RL 1	RL 2	RL 3
Low (0-25)	RL 1	RL 1	RL 1	RL 2

Control bands:
RL 1: General ventilation
RL 2: Fume hoods or local exhaust ventilation
RL 3: Containment (glove box or closed cabinet)
RL 4: Seek specialist advise

Fig. 1 Control Banding Nanotool[1] model

References

1) S.Y. Paik, D.M. Zalk, P. Swuste *Application of a pilot control banding tool for risk level assessment and control of nanoparticle exposures, Ann. Occup. Hyg., 52 (6) (2008) 419-428*