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Existing Standards and Recommendations

Standards and guidelines for controlling worker exposures to RCFs vary in the United States. Other governments and international agencies have also developed recommendations and occupational exposure limits that apply to RCFs. Table 7–1 presents a summary of occupational exposure limit standards and guidelines for RCFs.

Within the United States, the RCFC formally established a recommended exposure guideline of 0.5 f/cm^3 as an element of its product stewardship program known as PSP 2002, which was endorsed by OSHA as a 5-year voluntary program [OSHA 2002]. As part of that program, the RCFC recommends that workers wear respirators whenever the workplace fiber concentration is unknown or when airborne concentrations exceed 0.5 f/cm^3 . This exposure guideline was established by the RCFC on October 31, 1997, and replaces the previous exposure guideline of 1 f/cm^3 set by the RCFC in 1991.

Before this agreement, the OSHA General Industry Standard was most applicable to RCFs, requiring that a worker's exposure to airborne dust containing $<1\%$ quartz and no asbestos be limited to an 8-hr PEL of 5 mg/m^3 for respirable dust and 15 mg/m^3 for total dust [29 CFR 1910.1000].

NIOSH has not previously commented on occupational exposure to RCFs. However, in addressing health hazards for another SVF (fibrous glass), NIOSH [1977] recommended an exposure limit (REL) of 3 f/cm^3 as a TWA for glass fibers with diameters $\leq 3.5 \mu\text{m}$ and

lengths $\geq 10 \mu\text{m}$ for up to 10 hr/day during a 40-hr workweek. NIOSH also recommended that airborne concentrations determined as total fibrous glass be limited to a 5 mg/m^3 of air as a TWA. At that time, NIOSH concluded that exposure to glass fibers caused eye, skin, and respiratory irritation. NIOSH also stated that until more information became available, this recommendation should be applied to other SVFs.

The Agency for Toxic Substances and Disease Registry (ATSDR) calculated an inhalation minimal risk concentration of 0.03 f/cm^3 for humans based on extrapolation from animal studies [ATSDR 2002]. The Agency used macrophage aggregation, the most sensitive indicator of inflammation from RCFs, as the basis for this value. Calculation of this value is based on exposure assumptions for general public health that differ from those used in models for determining occupational exposure limits.

ACGIH proposed a TLV of 0.1 f/cm^3 as an 8-hr TWA for RCFs under its notice of intended changes to the 1998 TLVs [ACGIH 1998]. On further review, this concentration was revised to 0.2 f/cm^3 [ACGIH 2000]. ACGIH also classifies RCFs as a suspected human carcinogen (A2 designations) [ACGIH 2005]. On the basis of a weight-of-evidence carcinogenic risk assessment, the EPA [1993] classified RCFs as a Group B2 carcinogen (probable human carcinogen based on sufficient animal data).

ACGIH and EPA designations are consistent with that of the International Agency for Research on Cancer (IARC), which classified

Table 7–1. Occupational exposure limits and guidelines pertaining to RCFs*, by country

Country	Regulated substance	Exposure limit [†]	
Australia	Synthetic mineral fibers	0.5 f/cm ³	
	Inspirable dust	2 mg/m ³	
Austria	Total dust (lists superfine fibers as suspected carcinogen)	10 mg/m ³	
Canada	RCFs	0.5 f/cm ³	
Denmark	Manmade mineral fibers	1 f/cm ³	
	Total dust (nonstationary work site)	5 mg/m ³	
Finland	Glass wool and mineral wool	10 mg/m ³	
France	General dust, mineral wool	10 mg/m ³	
Germany	Synthetic vitreous fibers	0.5 f/cm ³	
Netherlands	RCFs	1 f/cm ³	
New Zealand	Synthetic mineral fibers	1 f/cm ³	
Norway	Synthetic mineral fibers	1 f/cm ³	
Poland	Glass wool	2 f/cm ³	
	Total dust	4 mg/m ³	
Sweden	Synthetic inorganic fibers	1 f/cm ³	
United Kingdom [HSE 2004]	Machine-made mineral fibers (except RCFs and special-purpose fibers)	2 f/cm ³	
	RCFs	1 f/cm ³	
	Total dust (gravimetric limit)	5 mg/m ³	
United States:	ACGIH	RCFs	0.2 f/cm ³
	ATSDR [2002] [‡]	RCFs	0.03 f/cm ³
	NIOSH [§]	RCFs	0.5 f/cm ³
		Glass fibers, other SVFs [NIOSH 1977]	3 f/cm ³
		Total fibrous glass	5 mg/m ³
OSHA [2002]	RCFs	0.5 f/cm ³	
	Respirable dust (<1% quartz, no asbestos)	5 mg/m ³	
	Total dust (<1% quartz, no asbestos)	15 mg/m ³	

Source: Adapted and updated from U.S. Navy [DOD 1997].

*Abbreviations: ACGIH=American Conference of Governmental Industrial Hygienists; ATSDR=Agency for Toxic Substances Disease Registry; NIOSH=National Institute for Occupational Safety and Health; OSHA=Occupational Safety and Health Administration; RCFs=refractory ceramic fibers; REL=recommended exposure limit; TWA=time-weighted average.

[†]8-hr TWA unless otherwise specified.

[‡]Inhalation minimal risk level based on general public health assumptions, not occupational exposure.

[§]The NIOSH REL is established as a TWA for up to a 10-hr work shift in a 40-hr workweek.

ceramic fibers, including RCF, as “possibly carcinogenic to humans (Group 2B)” [IARC 1988, 2002]. The IARC characterization was based on “sufficient evidence for the carcinogenicity of ceramic fibers in experimental animals” and a lack of data on the carcinogenicity of ceramic fibers to humans [IARC 1988, 2002]. DECOS [1995] determined that “RCFs may pose a carcinogenic risk for humans,” and set a health-based recommended occupational exposure limit of 1 f/cm³.

The German Commission for the Investigation of Health Hazards of Chemical Compounds in the Work Area published a review of fibrous

dusts [Pott 1997] classifying RCFs as category IIIA2, citing “positive results (for carcinogenicity) from inhalation studies (often supported by the results of other studies with intraperitoneal, intrapleural, or intratracheal administration).”

In the United Kingdom, the Health and Safety Commission of the Health and Safety Executive has established a maximum exposure limit for RCFs of 1.0 f/ml of air, with the additional advisory to reduce exposures to the lowest as reasonably practicable concentration based on the category 2 carcinogen classification for RCFs [HSE 2004].