Decontamination of a Centrifuge After a Rotor Explosion

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CENTRIFUGE ACCIDENTS that involve infectious disease organisms represent a hazard not only to personnel within a laboratory, but also to persons in other parts of the facility. This hazard is primarily due to the spread of contamination by contact with contaminated surfaces, for example, walls, bench tops, personal and protective clothing, skin surfaces, and more importantly, infectious aerosols generated during the explosion and carried throughout the facility (*1–3*).

The incident we describe occurred when an investigator was attempting to concentrate vesicular stomatitis virus from a large volume of cell culture medium. The type 19 rotor used was the largest fixed-angle rotor made by the Beckman Company. The maximum rating for this rotor is 19 krpm (Beckman

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Figure 1. Canopy with electric frying pan in place

technical data). Because of its extensive use, this rotor was derated to 17 krpm. Despite this derating, the technician placed the rotor into a Beckman L3-50 ultracentrifuge, set the speed control at 41 krpm, and then left the laboratory. Shortly thereafter, the rotor exploded.

A protocol based on the procedure for the decontamination of a biological safety cabinet was used (*4*). A canopy of 4 mil polyethylene sheeting was constructed over the centrifuge (fig. 1). To make a gastight, leak-proof enclosure, the canopy was sealed to the floor with 3-inch duct tape (fig. 2). All seams in the plastic were sealed with duct tape. In this procedure, formaldehyde gas is generated from paraformaldehyde flakes. If this decontaminant is to be effective, the relative humidity must be raised above 60 percent (*5*); this was accomplished by boiling water in a frying pan placed under the canopy until condensation appeared on the inner surface of the plastic. The paraformaldehyde was then vaporized by the heat from a second frying pan containing 0.3 gram per enclosed cubic foot of air under the enclosure. In this case, we estimated the volume to be 56 cubic feet and therefore used 18 grams of paraformaldehyde flakes. After all the paraformaldehyde was vaporized, both electrical connections for the frying pans were disconnected and the canopy was kept sealed for 1 hour. The use of formaldehyde gas as a fumigant has been proved effective against bacteria, bacteriophages, and viruses (*5*).

The canopy was then ventilated. The exhaust ventilation was provided by a laboratory fume hood with a face velocity of 119 linear feet of air per minute. A 10-foot length of 8-inch diameter flexible duct was attached to a galvanized sheet-metal flange fabricated to fit the front opening of the fume hood

Figure 2. Exhaust connection and sealed canopy

(fig. 3). The canopy was removed after 20 hours of exhaust ventilation.

Damage to the centrifuge was as follows:

1. The force of the explosion was so extensive that the centrifuge was lifted from its leveling stabilization footings (fig. 4), turned 180°, and moved about 4 feet.

2. The centrifuge rotor and chamber were destroyed (figs. 5, 6, and 7). The white object in figure 5 is what remained of a centrifuge bottle. Close examination revealed that the rotor overspeed safety pins had been removed before the equipment was used (fig. 7).

3. The force of the explosion blew the half-inch stainless steel door from its support tracks and bent it slightly (fig. 8).

Fortunately, no one was injured. The operator turned the unit on and left the room. This procedure

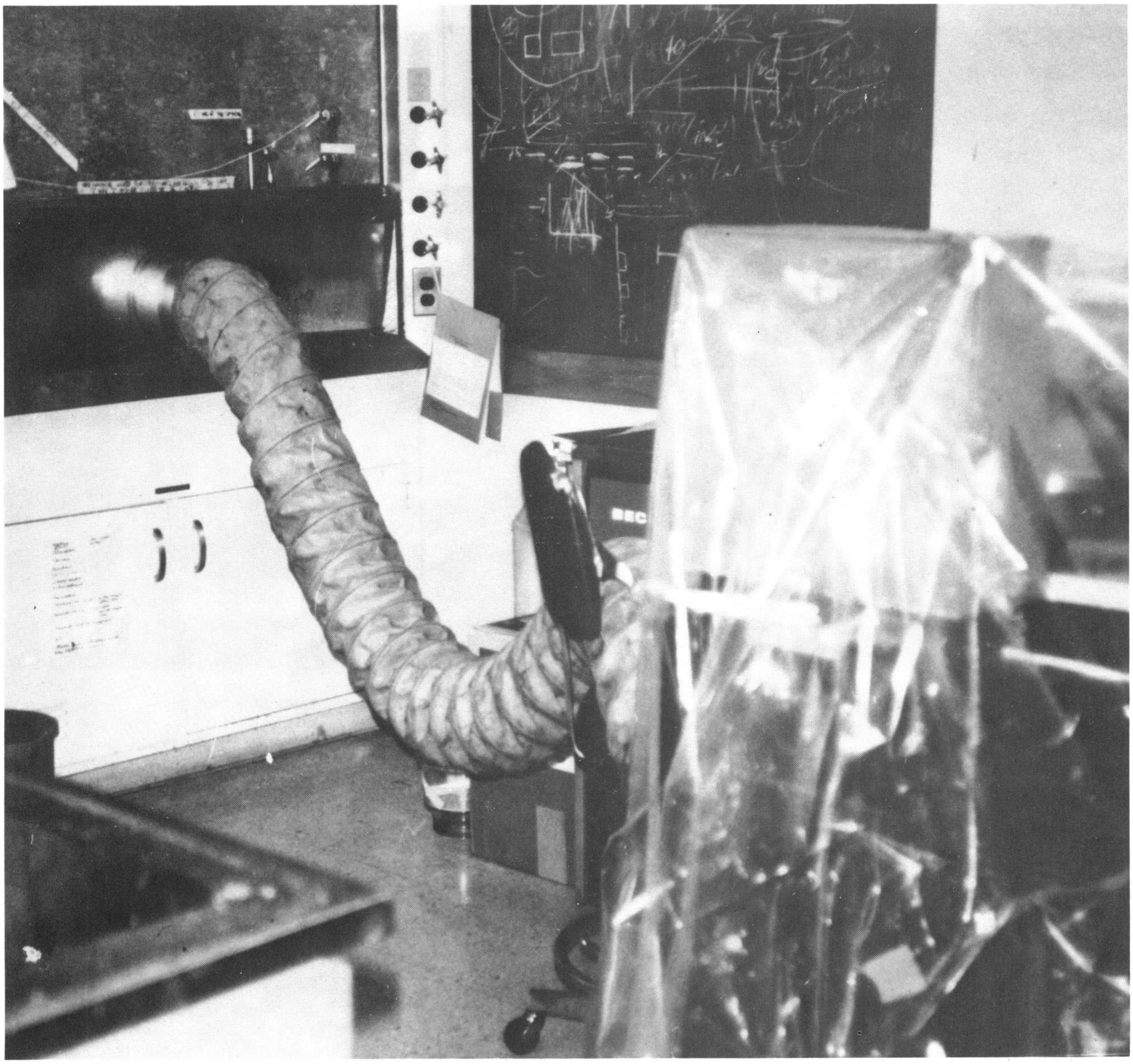

Figure 3. Exhaust connection to fume hood

is contrary to the operational instructions that were clearly posted on the wall above the centrifuge (fig. 1). These instructions indicate that the operator must be present until the desired speed is obtained. If the technician had been present she may have seen that the rotor had exceeded 17 or 19 krpm and corrected the situation. If the technician had not noticed the overspeed condition, she could have been seriously injured.

Centrifuge accidents result from equipment failure or operator error, or both. Equipment failure can be minimized through the implementation of a preventive maintenance program that includes periodic inspection and service of both the centrifuge and rotor, periodic inspection of rotor safety control elements (overspeed pins or decals), and accurate records on the rotor used. While operator error can be reduced by adequate supervision, strict adherence to the instructions in the operation manual is mandatory.

In this situation, the sequence of events was so improbable that it was not possible to predict this accident. In spite of the derating of the rotor, the operator set the speed control at 41 krpm (fig. 9)—which far exceeded the maximum. Normally, overspeed control is provided by speed control pins or decals. Unfortunately, the pins had been re-

Figure 4. Leveling-stabilization footings

Figure 5. Centrifuge chamber and bottle

Figure 6. Pieces of exploded rotor removed after decontamination

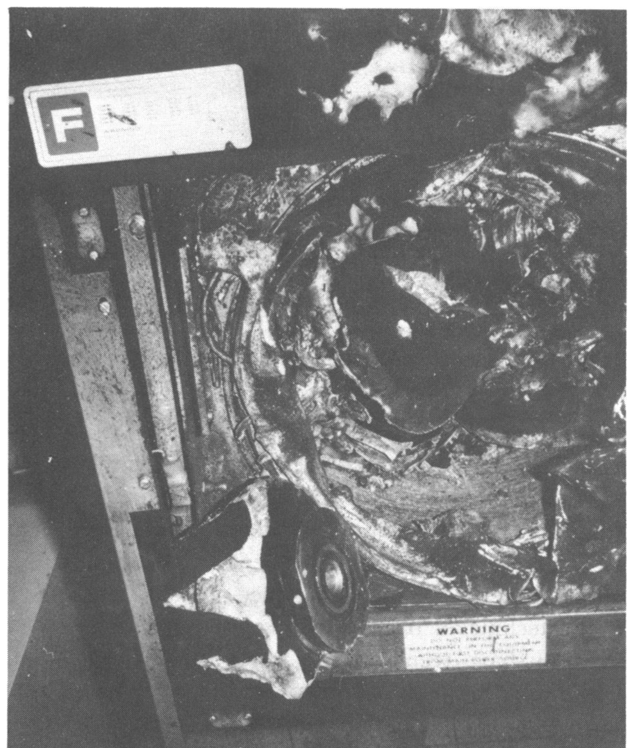

Figure 7. Base of rotor, with overspeed safety pin removed, and centrifuge chamber

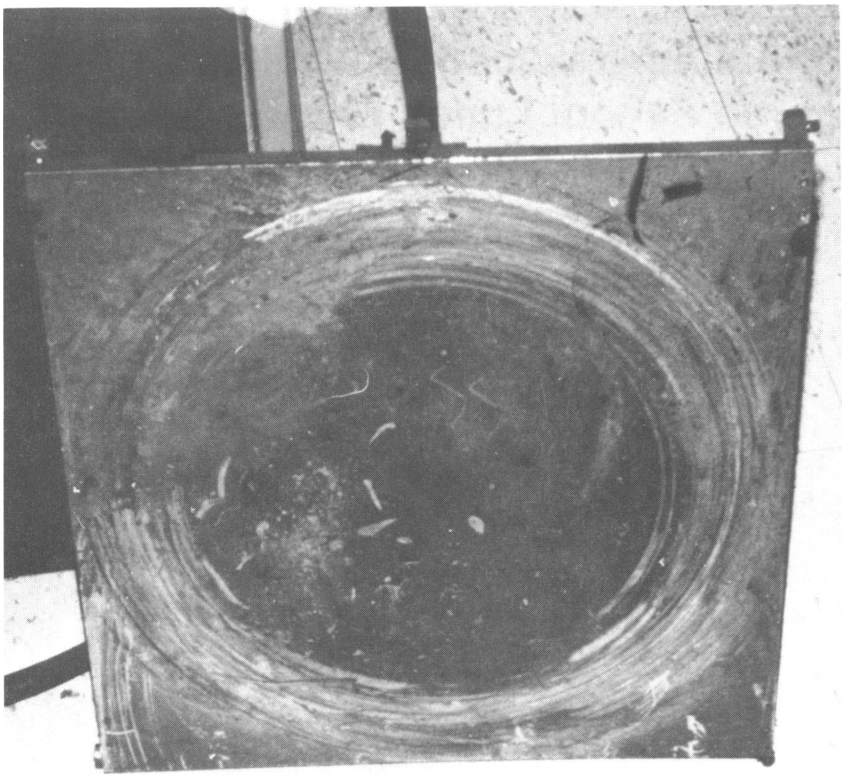

Figure 8. Centrifuge chamber cover

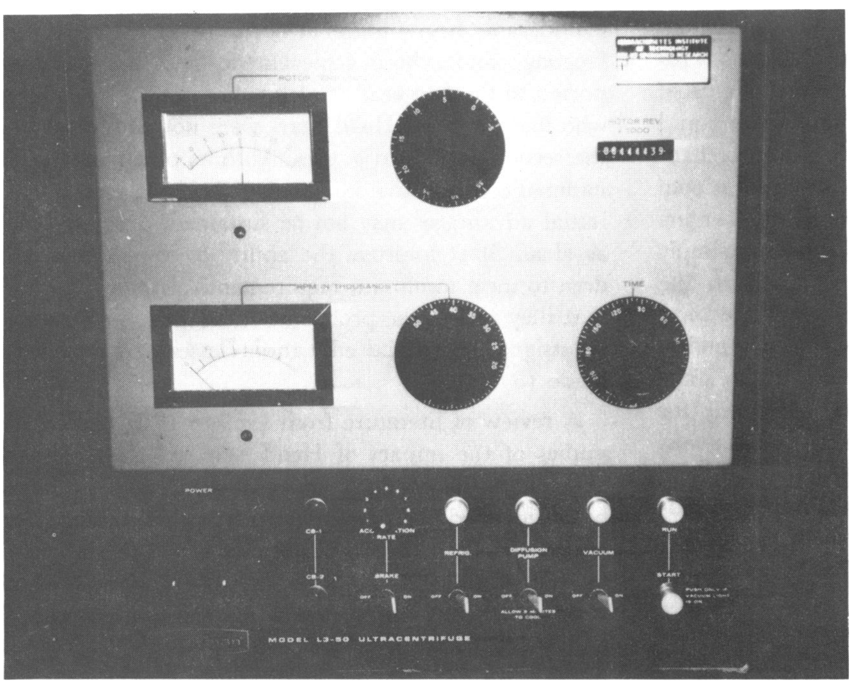

Figure 9. Control pan Model L3–50 Ultracentrifuge; speed control knob is set at 41 krpm

moved from this rotor (fig. 7), and the rotor and centrifuge were purchased before the overspeed decal system was implemented by the Beckman Company.

Although we have always required investigators to keep adequate records for centrifuges and rotors and to have service representatives inspect and maintain the equipment, it is impossible to inspect for and guard against operator error. No personnel, to our knowledge, became ill as a result of this accident. Fortunately, vesicular stomatitis virus is highly susceptible to heat and loses its infectivity very rapidly (R. Weinberg, PhD, associate professor of biology, Massachusetts Institute of Technology).

The episode described here clearly indicates that in order to prevent such accidents strict adherence to proper operational procedures is vital.

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