PRELIMINARY SURVEY REPORT:

Bell Helicopter Textron
Plant 1
Fort Worth, Texas

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DATE OF SURVEY:
July 15, 1981

REPORT WRITTEN BY:
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DATE OF REPORT:
January 19, 1982

REPORT NO.:
ECTB 108-14a

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Public Health Service
Centers for Disease Control
National Institute for Occupational Safety and Health
Division of Physical Sciences and Engineering
Engineering Control Technology Branch
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PURPOSE OF SURVEY:

To observe the processes involving adhesives, with emphasis on the method of application and the associated occupational health hazard controls.

EMPLOYER REPRESENTATIVES CONTACTED:

Mr. Mike Gross, Manager, Safety and Fire Protection
Mr. Neil Blatnick, Industrial Hygienist
Mr. Bob Lewis, Safety Engineer

STANDARD INDUSTRIAL CLASSIFICATION CODE OF PLANT:

3721: Aircraft

## Introduction

Industrial adhesives may involve agents, such as formaldehyde, organic solvents, and a variety of additives, which pose potential occupational health hazards. An appropriate implementation of control technology may prevent the overexposure of workers to these substances.

The Engineering Control Technology Branch of NIOSH is conducting a research study to document control methods associated with the industrial use of adhesives. The first phase of this project involves preliminary surveys to assess the application of control technology in conjunction with the use of adhesives in a number of industries. The information gathered will be used to focus second phase efforts on the industry which can benefit most from further study and to plan for a second, more detailed survey at this plant if it is selected for in-depth study.

On this preliminary visit, the NIOSH survey team met with Mr. Neil Blatnick, Industrial Hygienist, and Mr. Bob Lewis, Plant Safety Engineer. We also met briefly with Mr. Mike Gross, Manager of Safety and Fire Protection. During the survey, we talked with Mr. R. A. Scott, General Supervisor of areas 37, 38 and 65.

Adhesives are used to make a number of helicopter components. In making rotor blades and body panels, a thin exterior skin is bonded to a lightweight core structure. Body panel inserts are bonded and sealed in the receiving holes. Plexiglas windows are bonded to metal frames, and a sealant is applied on body seams after assembly to give a smooth, watertight finish. Adhesives are also used during upholstering.

## Description of Facilities

The manufacturing facilities in which we observed the processes using adhesives comprise part of a multi-building complex, including corporate offices. The site is located in a mixed industrial/commercial/residential area ten miles east of downtown Fort Worth. Of the 5000 people employed here, approximately 2600 are production workers.

Building 2, covering over 300,000 square feet of area, houses a number of processes including rotor blade manufacture and helicopter final assembly. Approximately 280 people work in this building, with over two thirds of them working the main shift and only a few manning the shop on the graveyard shift. A bank of enclosed autoclaves, used to cure the rotor blade adhesive bonds, is situated on the back side of this building.

Contoured body panels are formed in building 14, a smaller (less than 30,000 square feet) and newer structure behind building 2. The work force for this building is approximately 70, with over three-fourths of these people working the first of two shifts. Two free-standing autoclave chambers are installed near the west doorway of the open bay portion of the building.

## Description of Processes

A rotor blade is made by bonding a thin skin (usually metal) to a lightweight core, incorporating structural reinforcements. The interior surfaces are

first sprayed with a corrosion-inhibiting primer specified by the adhesive manufacturer. A sheet of epoxy film adhesive is placed between the skin and the core. This rotor blade assembly is then encased in a plastic liner, and a fitting is temporarily attached to enable the trapped air to be evacuated. The suction removes air pockets and compresses the adhesive between the skin and the core to effect a strong bond, free of voids.

Rotor blades were once made by brushing the adhesive onto solid wood laminates. Film adhesives have been used since the early fifties; the metal honeycomb was introduced in the mid-fifties. Recently, synthetic composites, made by machine winding fibers around a form, have been developed. Lighter and stronger than the honeycomb substrate, composites are being incorporated more and more into rotor blade core structures.

One of two different primers may be applied, depending on the film adhesive to be used. Both are low (5-10%) solids epoxy solutions in organic solvents. These primers may be formulated for oven or room temperature drying, depending on the solvent composition. Chlorothene-NU, a commercial formulation of (inhibited) methyl chloroform is used as the solvent for one primer. The solvent for the other primer is a mixture of methyl ethyl ketone (MEK) and 2-nitropropane. The manufacturers specify the drying times to be 30 and 120 minutes, respectively at room temperature.

Contoured body panels are created by first laying up an outer skin of fiberglass on a form. Then a thin layer of honeycomb is applied over an intervening sheet of film adhesive. Finally, an interior fiberglass surface is applied over another sheet of film adhesive. To prepare for autoclaving, a plastic film incorporating a fitting through which the enclosed air can be evacuated, is applied over face of the form. To seal the edges, a firm bead of solid but flexible sealant is placed around the perimeter of the form, after first wiping with MEK. The plastic film is pressed onto the sealant; a vacuum is pulled on this envelope; and the panel is ready to be cured in an autoclave. After the cured panel is removed, the form is cleaned and coated with a release agent, readying it for reuse.

The release agent is mostly organic solvent. One product being used is 95% methylene chloride. Another one, not observed in use, is reported to contain 30% methylene chloride and 60% methyl chloroform. The temporary sealant is formulated to be non-curing. It comes packaged as a strip of brown material, approximately one-eighth inch thick and half an inch wide, rolled with a separating layer of release paper.

Finished rotor blade and body panel surfaces must be smooth. Filling and fairing surface irregularities is accomplished using epoxy adhesives. These two-part, room-temperature curing, epoxy pastes are applied with a spatula. In adddition to these adhesives, some of the film adhesive is exuded from the lap joints during autoclaving. The excess material is removed using hand-held reciprocating sanders. Also, raised imperfections on the surface of formed composite core sections are smoothed using a hand-held rotary wheel sander.

Since the honeycomb material is a poor substrate in which to anchor a threaded fastener, in order to attach items to these panels, mating fastener plugs must first be inserted. An epoxy adhesive is used to install these inserts in sandwich panels. First, the holes are drilled into the bonded panels. The

insert is then pressed into the panel. Practically every insert has two fill holes through which the potting adhesive is injected. Thus, the adhesive seals the plugged hole as well as holding the insert in place. After the epoxy has cured, the area is sanded to obtain a smooth finish.

The product used is a two part epoxy, Hysol EA 934-NA, which in standard formulation contains asbestos. Bell Helicopter has specified that this product be supplied with a filler matrix other than asbestos. When mixed, the adhesive is a gray, thixotropic paste. Full cure takes one week at room temperature, but it begins to harden immediately having only a forty minute pot life before it becomes difficult to work with.

Adhesives are also used for bonding metal frames to plexiglas windows and for applying upholstery, however, these processes were not observed. Some body sections, such as the tail boom, are made from metal panels rivited to a metal frame. Mechanical fasteners are used for final assembly to permit future disassembly for maintenance and repair. Prior to painting, a polysulfide sealant is applied to certain body seams. This sealant cures at room temperature but in service withstands high temperatures and humidity and is impervious to common aviation fuels.

The polysulfide sealants are high solids solutions with toluene as the solvent. After mixing, the thick gray paste requires 2 weeks at room temperature to fully cure.

Description of Controls

The primer used in conjunction with the film adhesives is sprayed on as the parts pass through an automated, ventilated enclosure on a roller conveyor. Even though room-temperature drying primers are used, the primed surfaces also pass through a ventilated drying oven. This ventilated drying could be significant in controlling exposure to 2-nitropropane, a potentially hazardous solvent in one of the primers. In addition to its low threshold limit value, a ceiling limit of 25 ppm, and its known liver toxicity, 2-nitropropane is a suspected carcinogen based on recent animal exposure experiments. MEK and methyl chloroform are less toxic, having time-weighted average TLV's of 200 and 350 ppm, respectively.

The film adhesives nominally contain less than 2% volatiles; a recent analysis showed less than 0.5%. In addition to the release paper, which facilitates handling, the workers in this area wear white gloves to prevent skin contact with critical surfaces. Air suctioned from the enclosed piece being bonded, as well as the atmosphere in the autoclave, is vented to the outside. At one time, the switch to adhesive sheets may have been a significant engineering control, but film adhesives are now standard practice in the aerospace industry.

Rotor blade and body panel surfaces are sanded in specially constructed, ventilated areas. After autoclaving, bond interfaces are sanded in a large booth with a bank of filters on the back wall. Air is drawn through these filters and reintroduced through diffuser panels which cover the ceiling. Additional air may be drawn through the open front of the enclosure. Pre-paint sanding is performed on a ventilated platform with air drawn through a grated floor. Filtered and recirculated air is introduced through overhead

diffuser panels. Body panels are sanded in a room with 5 large doorways. Air drawn through floor gratings is filtered and may then be exhausted to the outside or recirculated through ceiling diffuser panels. These systems appear to be effective at controlling dust from sanding based on smoke-tube visualization and personal observations. No direct ventilation is provided for the potting adhesives or sealants, but these products contain a low percentage of volatile components. Formulations without asbestos are being used, a substitution made even more significant by the fact that the potting adhesives are sanded. Due to the short pot life, only small batches are prepared at any one time.

Respirators and goggles are available on request. One worker who sanded in a ventilated booth chose to wear a 3M disposable mask, putting on a new one each morning and one after lunch. He did not, however, find it necessary to wear goggles to keep dust from his eyes. A qualitative fit testing program is employed for those who wear some sort of respiratory protection. Safety glasses are required for all production workers; hearing protection is required for those working in high noise areas.

Description of Programs

Industrial hygiene and safety is organizationally under the Safety and Fire Protection Department within the Division of Compensation and Benefits. In addition to the manager of safety and health, there is an industrial hygienist and two safety engineers. They monitor for potentially hazardous and unsafe conditions and oversee the distribution and use of all personal protective equipment. In the workplace, hearing protectors are available at a first aid station.

The Medical Department consists of a physician and registered nurses. The doctor provides primary medical care and gives physical examinations during the 1st shift; the 2nd shift is staffed by the nurses. Each employee receives a pre-employment physical exam. Workers occupationally exposed to asbestos or lead are monitored medically. Those people working in high noise areas are given an audiometric screening test every other year.

The Aetna Insurance Company carries their fire and casualty insurance. An engineer from their Dallas office makes quarterly visits.

Conclusions and Recommendations

From initial observations, it seems that potential occupational health hazards at this facility are well controlled. If the aerospace industry is selected for in-depth study, this Bell Helicopter Textron plant would be a strong candidate for a detailed survey.

It is suggested that 2-nitropropane be sampled for during a spraying operation with Metlbond 6726 primer. Note that its threshold limit value of 25 ppm is a ceiling limit, not an 8-hour time-weighted average. If the sampled levels are high, providing a longer residence time in the existing dryer or switching to another primer (or adhesive/primer system) which uses a less hazardous solvent should be considered.