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WADC TECHNICAL REPORT 54-94

URINE EVAPORATOR

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AERO MEDICAL LABORATORY

FEBRUARY 1954

WRIGHT AIR DEVELOPMENT CENTER

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URINE EVAPORATOR

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Aero Medical Laboratory

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SEO No. 698-29

Wright Air Development Center
Air Research and Development Command
United States Air Force
Wright-Patterson Air Force Base, Ohio

FOREWORD

Preliminary tests of a urine evaporator were conducted by personnel of the Aero Medical Laboratory, Directorate of Research, Wright Air Development Center, Wright Patterson Air Force Base, Ohio, in October 1951. A performance specification, Exhibit WCRDM-25, was prepared in November 1951, and shortly thereafter bid proposals for the fabrication of the first prototype were received from industry. However, it was not until November of 1952 that a contract for this development was awarded to the O and M Machine Company, Los Angeles, California.

Performance tests on the first prototype commenced with laboratory tests in late summer, 1953. These tests were completed in November 1953, after the equipment had been in use aboard a C-47 aircraft for a period of one month.

Project Engineers for this project have been R. E. Sheets, 1st Lt, USAF; R. R. Chalquest, 1st Lt, USAF and W. J. McNeil, 1st Lt, USAF, respectively. This project was administered under Service Engineering Order No. 698-29, "Medical and Sanitation Aircraft Equipment."

ABSTRACT

Methods now in use for the disposal of urine aboard USAF aircraft include overboard drains and inboard collection tanks. Both have drawbacks, and neither is entirely satisfactory.

In an attempt to overcome the deficiencies of urine disposal techniques, an assembly that evaporates urine prior to overboard venting has been designed, fabricated and tested. This urine evaporator received urine from standard relief facilities. The urine after entering the evaporator was deionized and evaporated. The vapor was vented overboard.

Laboratory and flight tests indicated that the use of deionization resins effectively removed the corrosive properties of urine. However, their use is considered to be impractical because large quantities were required for practical application. Tests further indicated that evaporation of urine does not remove its corrosiveness. Therefore, no benefits can be foreseen from the use of the urine evaporator, and there are no plans for the continuation of this project.

PUBLICATION REVIEW

This report has been reviewed and is approved.

FOR THE COMMANDER:

J. M. Henderson, Col USAF (MSC)
JACK BOLLERUD
Colonel, USAF (MC)
Chief, Aero Medical Laboratory
Directorate of Research

URINE EVAPORATOR

INTRODUCTION

The USAF Handbook of Instructions for Aircraft Designers calls for the installation of separate relief and toilet facilities aboard aircraft having a flight duration in excess of six hours. Aircraft with a flight duration of two to six hours require only relief horns. And aircraft with a flight duration of less than two hours require no sanitation facilities.

It is common practice among the commercial airlines to provide toilet facilities only. Urine is removed during regular servicing of the toilets, and the installation of urinals and relief horns is eliminated.

Methods of urine disposal aboard Air Force aircraft are overboard vents and inboard collection tanks. Neither method is entirely satisfactory.

Drain lines and overboard vents frequently freeze and clog aboard aircraft that fly at high altitudes or in cold weather. Individuals that use relief horns and urinals with frozen drain lines experience extreme discomfort. It is also difficult to so locate the vent on high speed aircraft so that spray will not strike the fuselage or other surfaces.

Urine that comes in contact with unprotected metal surfaces builds up unsightly sludge deposits and corrodes. Several corrective measures have been tried. These include use of corrosion resistant paints, frequent washing and coating with plastics. Of these, corrosion resistant paints are most commonly used. But all are time consuming procedures. At best they only inhibit corrosion.

An undesirable feature of inboard collection tanks is the necessity for their periodic removal and cleaning. If not serviced frequently, these tanks can become the source of objectionable odors. Such odors have been known to contaminate crew compartments aboard tactical aircraft.

HISTORY

The Aero Medical Laboratory, Directorate of Research, Wright Air Development Center, is investigating new approaches to the problem of inflight disposal of urine.

During October, 1951, preliminary tests were conducted by Aero Medical Laboratory personnel to determine the feasibility of evaporating urine and venting the vapor overboard. The purpose of these tests was to formulate plans for the development of a small evaporating assembly that

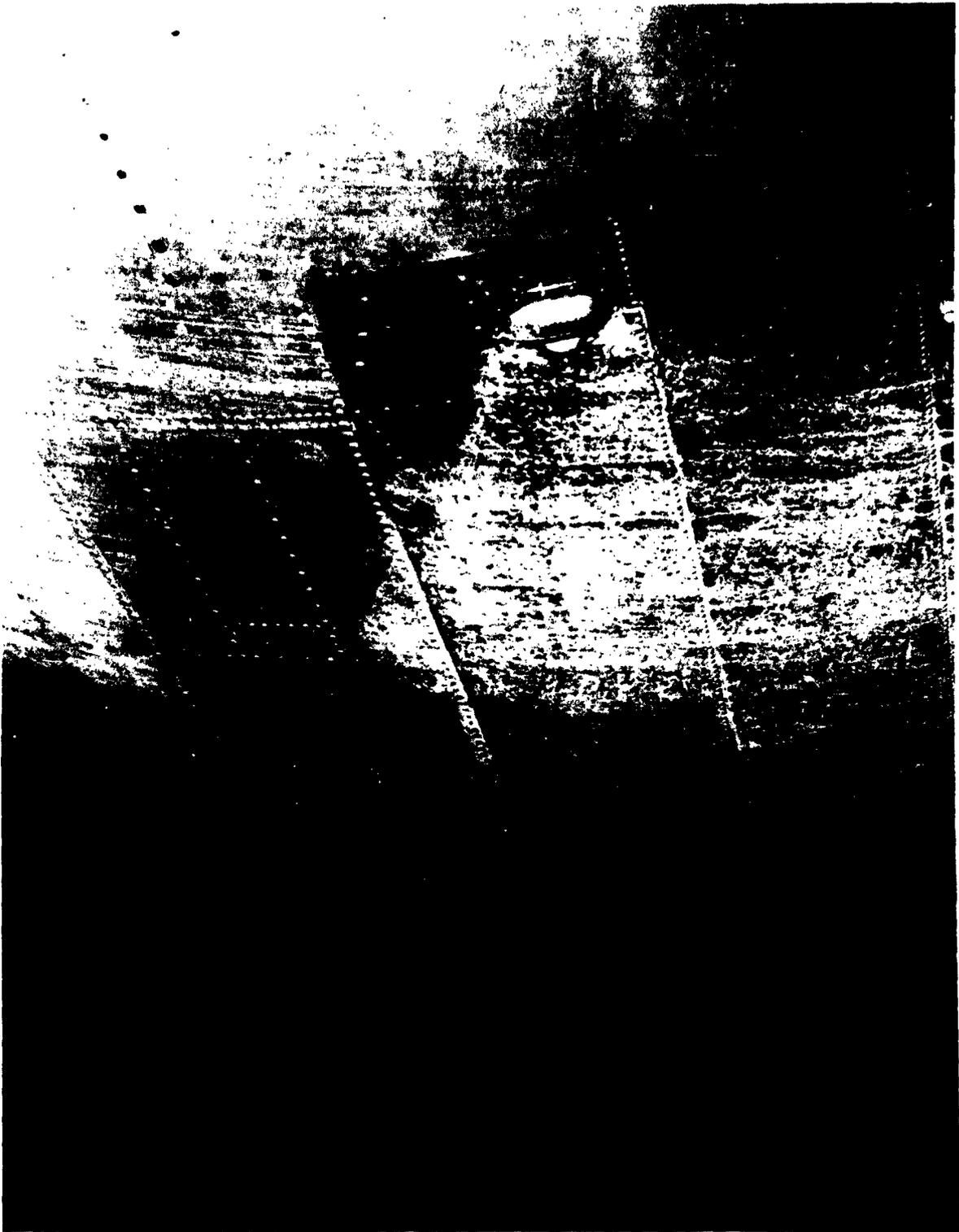


Figure 1. Urine Evaporator, showing overboard vent.

would utilize cabin heated air as the evaporating medium. It was thought that urine after passing through an evaporator would lose its corrosive properties and, being a gas, would dissipate without striking the aircraft.

Exhibit WCRDM-25 was prepared on 19 November 1951. This exhibit described an assembly designed to receive urine from standard relief facilities. It further stipulated that the urine was to be absorbed by an expendable wick through which warm air could be passed. A 25 cubic foot/minute flow of 120°F air was prescribed to evaporate liquids from the wick. It was assumed that salts and other residue would remain in the wick while innocuous liquids passed overboard in a gaseous state.

The developmental program was divided into four phases. Each phase included the fabrication of one test item.

- (1) Phase 1: One-man Assembly.
- (2) Phase 2: Three-man assembly.
- (3) Phase 3: Five-man assembly.
- (4) Phase 4: Nine-man assembly.

The four units were to have the capacity of evaporating normal amounts of urine excreted by one, three, five, and nine men respectively with the prescribed temperature and air flow.

A procurement request was initiated on 10 December 1951 for the fabrication of four evaporators. Several proposals were received and evaluated by the Wright Air Development Center, and on 17 November 1952 Contract AF 33(600)-22516 was awarded to O and M Machine Company, Los Angeles, California.

The one-man urine evaporator was received by the Wright Air Development Center on 13 July 1953. Due to a utilities failure, laboratory testing of the evaporator was delayed until mid August 1953. After laboratory evaluations were completed, the one-man unit was installed aboard a C-47 aircraft. Flight testing was conducted during the period of 19 October 1953 through 17 November 1953.

DESCRIPTION

The one-man urine evaporator built under the Air Force contract by O and M Machine Company consists basically of three components. These are a de-ionization chamber, a storage chamber, and a wick. All these parts are circular in shape and easily accessible for inspection or servicing. The unit is approximately 13 inches outside diameter and five inches deep. Average diameter of the wick is 11 inches. The lid is attached by a V-band coupling which forms a tight seal.

The de-ionization chamber contains a filter of active anion and cation exchange resins for the urine to pass through. It is easily removed and does not hinder evaporation. The resins reduce cationic and anionic properties of urine to water. They do not remove nonionic impurities.

Urine, upon entering the evaporator, trickles through the de-ionization chamber and falls to the floor of the container. It then flows into the wick by capillary action. Warm air passes through the wick and evaporates the liquid before vapor is vented overboard.



URINE EVAPORATOR (DISASSEMBLED)

TEST PROCEDURES AND RESULTS

Laboratory evaluations began with some preliminary testing of ion exchange crystals. Testing of the first prototype urine evaporator began in the laboratory on 11 August 1953.

Amberlite MB-3, an active anion-cation exchanger, was selected for laboratory evaluation. In general, results showed that fresh crystals effectively removed corrosive properties of urine. However, a large quantity of exchange crystals was needed to de-ionize appreciable amounts of urine. It was also found that Amberlite MB-3 crystals lose their effectiveness too rapidly for practical application.

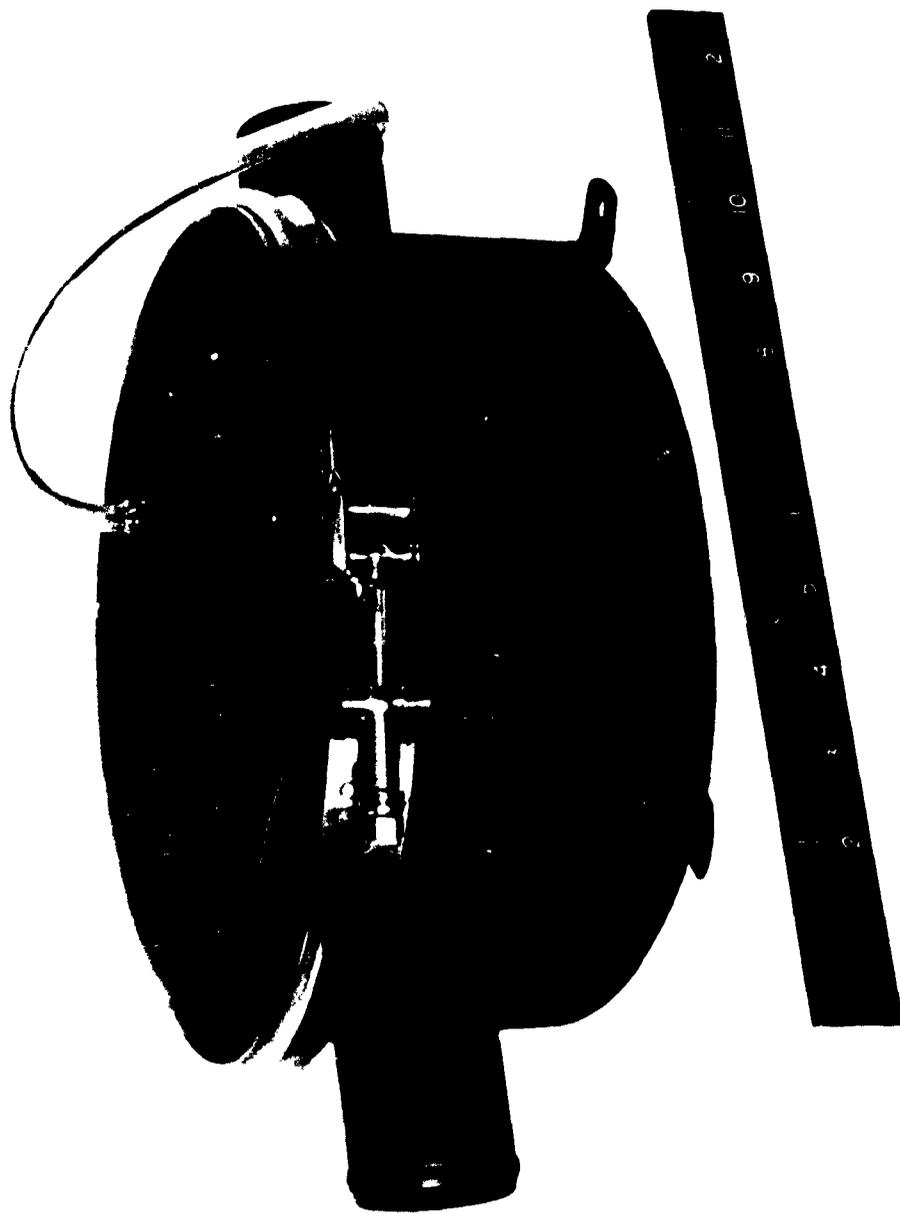
Laboratory Data gathered on the urine evaporator included the rate of evaporation of distilled water at various air flows and temperatures. With an average air flow of 11 cubic foot/minute and an average air temperature of 145°F, the unit evaporated liquids at rates varying from 1.25 milliliters per minute to 1.45 milliliters per minute. These conditions equaled 40 percent of the air flow and 120 percent of the temperature requirements specified in the exhibit. The unit exceeded its required evaporating capacity by 25 to 45 percent when operating under these conditions.

No urine was placed in the evaporator during laboratory testing. Only the rate of evaporation of distilled water was measured. Under these test conditions the unit functioned in a highly satisfactory manner.

In late October 1953, the urine evaporator was installed in the forward compartment of a C-47 aircraft for service testing. Hot air was piped to the unit from cabin heat ducts, and an overboard vent was placed approximately three feet forward and above the leading edge of the wing. (This was done to simulate the worst operating conditions, i.e. the evaporated urine would have the greatest possibility of striking the aircraft). A relief horn that drained directly into the evaporator was also installed. The opening of the overboard vent was placed flush with the fuselage. In this way the corrosiveness of the vapor would show its greatest effect in the shortest interval of time.

The aircraft flew at irregular intervals, and during the first two weeks only 400 milliliters of urine was evaporated. No adverse effects to either the evaporator or the aircraft was noted during this period. However, the ion exchange crystals in the evaporator became exhausted, further evidence that their use is impractical.

An estimated 2800 milliliters of urine was evaporated in the third and fourth weeks of testing. At the end of the fourth week a heavy deposit extending six feet from the vent opening rearward was observed. This deposit of a yellowish, gummy substance produced an unsightly streak on the aircraft body. Slight corrosion of the metal was noted. It was obvious that serious damage to the fuselage could result if the evaporator remained in use. Tests were discontinued, and the urine evaporator was immediately disconnected.



URINE EVAPORATOR (ASSEMBLED)

DISCUSSION AND CONCLUSION

Ion exchange crystals remove the corrosive properties of urine. But their use is limited since large quantities are required to de-ionize sufficient quantities of urine for practical use. Furthermore, they require periodic replacement or regeneration. This creates additional servicing problems.

The urine evaporator designed and fabricated by the O and M Machine Company is well constructed, and it performed its evaporating function in a highly satisfactory manner. However, the vapor upon entering the cold air stream strikes and condenses on the aircraft surfaces. The condensate discolors and corrodes aircraft metals much like untreated urine.

Use of the evaporator would require additional protective measures. Either the overboard vent would have to be located so that the condensate would not strike the aircraft or the exposed metals would have to be protected. These are the same protective measures used with the present method of direct venting.

Since the evaporation of urine by air at cabin heat temperatures before venting does not prevent corrosion of exposed metal surfaces, this method of disposing urine is, therefore, considered unsatisfactory. Further development of the urine evaporator has been halted, and there are no immediate plans for the continuation of this project. However, other approaches to the problem of inflight urine disposal will be sought.