CHEMICAL RESEARCH, DEVELOPMENT & ENGINEERING CENTER

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FOOD/DRINK/SPEECH SYSTEMS FOR RESPIRATORY PROTECTION

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This study was to identify concepts for improving the drinking and communication (speech) systems currently integrated into the XM40 protective mask and to provide a system for food intake.

A number of concepts were generated and evaluated for each of these functions, and the following recommendations were made: add a solid food injector system at the location of the mask voicemitter; improve the current drinking capability by enlarging the check valve assembly and lengthening the drinking tube; and improve the current speech capability by optimizing the voicemitter design or by developing a disposable self-contained microphone/amplifier/speaker system.

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(C2)

PREFACE

This research was supported by the U.S. Army Armament, Munitions and Chemical Command, Chemical Research Development and Engineering Center, Aberdeen Proving Ground, Maryland, under Contract No. DAAG-29-81-D-0100, Deliver Order No. 1383, and was monitored by the U.S. Army Research Office, Scientific Services Program, Research Triangle Park, North Carolina. The work was started in February 1985 and completed in August 1985. (ARO) Battelle!

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EXECUTIVE SUMMARY

In chemical-warfare operations, the use of individual protective equipment (IPE) may be required for extended periods (on the order of 72 hours). During this time, the soldier must be able to eat, drink, and communicate while wearing his protective mask. The XM40 mask, currently under development by the Army, provides capabilities for drinking and speech, but no capability for eating.

The Chemical Research and Development Center (CRDC) tasked Battelle to review prior studies of protective systems and identify and evaluate concepts that could be integrated into the mask to improve the communication and drinking capabilities and provide an eating capability.

As a first step in the program, a survey of the open literature was conducted and individuals in the Army and Air Force and at other Government facilities (U.S. and foreign), who are working in or have cognizance of the protection equipment area were contacted.

Following these efforts, concept-generation sessions were held with Battelle personnel with expertise in the appropriate technical areas. These sessions yielded 11 communications concepts, 6 drinking concepts, and 9 eating concepts. These concepts were evaluated and the following recommendations are made on the basis of the evaluation:

- Communications: Improve the current capability by optimizing the voicemitter design or by developing a disposable, self-contained microphone/amplifier/speaker system.
- Drinking: Improve the current capability by enlarging the check valve assembly and lengthening the drinking tube.
- Eating: Add a solid food injection system at the location of the mask voicemitter.

(F)

2.2.1 Army.

A discussion was held with Mr. Corey Grove at the Chemical Research and Development Center (CRDC) to discuss the status of eat/drink/speech systems. Based on this discussion, several items related to ongoing work and philosophy of eat/drink/speech systems were obtained. These related to the need for improvement, integration into the mask, and current work.

Need. There is an opinion in the user and developer community that personnel may have to operate in IPE up to 72 hours continuously. In order to do this, a method is desired of eating as well as improvement of the existing drinking concepts. Increased volume and improved clarity of speech are also required to overcome battlefield noise.

Integration. For producibility and maintainability reasons, it is desirable to build eat/drink/speech, the outlet valve, and other systems which couple to the mouth in the outlet valve/voicemitter assembly. This is to preclude the need for additional mask openings.

Current Work. There is not much of a problem with the drink system. With the current communication system, it is not possible to communicate effectively over loud noises. Neither is it possible to couple the system to a microphone to increase the volume and improve the clarity. The auxiliary voicemitter has made coupling with field telephones easier. An eating system being investigated by Natick uses a tube-type food. The food is pushed through a large nozzle which is attached to the top of the tube, and inserted through an opening in the mask into the mouth. It is believed that this opening is similar to that on the Israeli mask used for similar purposes. The Israeli mask is shown in figure 1. Currently, the U.S. Army Surgeon General will not allow use of a drink tube for eating because of the difficulty of

(*) @ Chamschlin '85 There was no MAA deficiency for fluid flow / mask human factors

(6)

earphones for sound pickup. Filtration might be needed to process out unwanted noise or to prevent amplification of sounds that are already loud enough to be heard or to a level that could damage the ear.

3.2. Drinking Concepts.

Canteens non M1 cap/ mask inlet pin never tested for vapor integrity 1990

The drinking system as presently designed has been reported to function satisfactorily. The concepts that are described below attempt to make the drinking process easier or safer.

D1. Longer inlet tube.

The present inlet tube on the outside of the mask is fairly short; increasing the length of the tube would make connection to the canteen easier and allow more movement by the soldier when drinking. The longer tube would have to be protected when not being used for drinking to avoid catching it on tree branches or other protrusions.

D2. Increase size of the check valve on inlet tube.

The present check valve is quite small. Handling the small valve, particularly reinserting it in the mask flap which protects the tip, when wearing bulky protective gloves, is difficult. If the valve were somewhat larger, attaching the valve to and detaching it from the canteen would also be easier. The larger valve cannot be permitted to adversely affect storage on the mask when not in use.

D3. Permanent attachment of inlet tube to canteen.

A long inlet tube would be attached to the canteen which is mounted on the soldier's torso. A valve near the mask is opened when the soldier drinks. This concept eliminates at least some of the connect/disconnect actions that must be taken during drinking,

(H)

In April 83, I was told by CRDC there was no need for an improved drink device for the mask.

3.6 Drinking Capability of the XM40 Mask.

The XM40 mask presently provides the soldier with the capability to drink fluids. It has been reported that the present drinking system design performs adequately in that it allows the soldier to drink in a safe manner, however, there are certain problems as discussed below. It may be possible that improvements can be made to the system. The present drinking system consists of two major parts: a canteen, and a drinking tube.

The canteen is fitted with a special cap that is connected to the inlet portion of the drinking tube. The canteen is hard bodied and cannot be compressed by hand.

The drinking tube consists of two parts: a short inlet tube that is outside the mask, and a drinking tube that is located inside the mask. The two tubes are connected by a short metal tube which penetrates the mask. A small check valve on the end of the inlet tube is designed to mate with a snap-connector in the canteen cap. When the drinking system is not in use, the inlet tube check valve is stored in a rubber protective pocket in the front of the mask.

When drinking, the soldier removes the inlet tube check valve from its protective pocket on the mask and inserts it into the female connector on the canteen. The soldier then blows air into the canteen and allows the pressurized canteen to force a small quantity of water through the drinking tube. If a large quantity of water is desired the blowing and sipping procedure must be repeated a number of times. During the drinking process the canteen must be held inverted, close in front of the mask. The drinking tube is short, so the canteen must be held fairly steadily to prevent pulling the mask away from the soldier's face. When finished drinking, the inlet tube is removed from the canteen and the check valve is reinserted into its protective pocket. Since the pocket is not visible through the mask lenses, the reinsertion process is done by feel or with assistance. The next time a drink is needed, the entire process must be repeated.

U.P. April '83 → See U.P. Chart - Binder I p 151-152 2063-2064

3.6.1 <u>Deficiencies of the Present Drinking System</u>.

In summary, the following are the perceived deficiencies with the present drinking system design.

1. The requirement to make repeated connections to the canteen until it is emptied increases the possibility of contamination entering the drinking system during each reconnection.

2. Handling of the inlet tube check valve is difficult because the valve is small and the protective gloves substantially reduce feel and dexterity. Such handling increases the potential for contamination.

3. The short inlet tube makes the connection to the canteen, and holding the canteen inverted during drinking, more tedious than if the tube were longer.

4. The hard canteen prevents free flow of water to the soldier and substantially slows the drinking process.

5. Reinsertion of the inlet tube check valve into its protective pocket is difficult because vision, feel, and dexterity are severely impaired by protective gear. Contamination of the inlet tube valve is likely unless the mask exterior is decontaminated before inserting the tube into the pocket.

3.6.2 <u>Suggestions for Improvement of the Drinking System on the XM40 Mask</u>.

The evaluation of the drinking system concepts resulted in a listing of concepts in order of acceptability. The concepts listed in order of preference are shown in table 3. Based on the data from the evaluators, Concepts D2, D5, and D1 are of approximately equal score.

Table 3. Concepts for Improving Drinking Capability of the XM40 Mask

Ranking	Concept No.	Concept Description
1	D2	Make the inlet tube check valve longer
2	D5	Squeezable, collapsible canteen
3	D1	Longer drinking tube
4	D6	Collapsible bag inside a hard canteen shell
R	D4	Mirror for aiding insertion of the check valve in its protective pocket
6	D3	Permanently attach the drink tube to the canteen

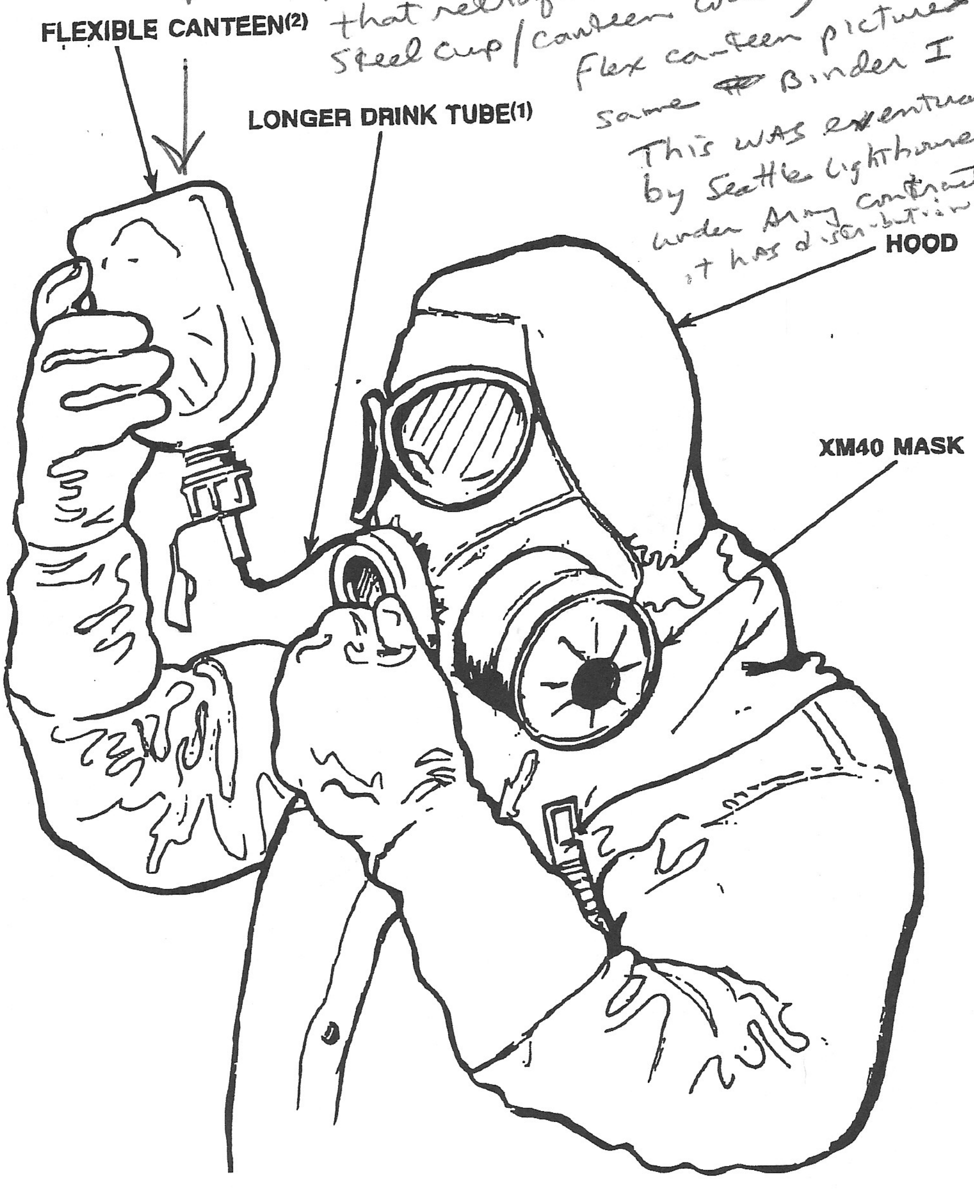
Figures 3 through 5 are conceptual drawings of how some of the above ideas might be implemented.

The purpose of the larger check valve (Concept D2) shown in figure 3, is to simplify handling by making the valve easier to manipulate when the soldier is wearing protective gloves which impair feel and dexterity. The grip area of the present valve is approximately 1.1 inches long by 0.44 inch in diameter. The valve is also partially hidden when in its storage pocket in the mask. Increasing the length and diameter of the valve is expected to make it easier to grip and manipulate.

The longer drinking tube (Concept D1) shown in figures 3 and 4 allows the soldier more freedom of movement than is possible with the present drink tube design when the soldier is connecting the inlet tube to the canteen and when he is drinking. The tube length should not be so great as to impair storage on the mask.

(K)

note that this Flexible canteen is the shape that retrofits into the standard steel cup/canteen cover; As does my Flex canteen pictured to do the same Binder I drawing #2077
This was eventually fielded by Seattle Lighthouse for the Blind under Army contract called HydroMax it has distribution in all PX-base shops



(1) LONGER DRINK TUBE ALLOWS BETTER VISION OF CONNECTION AND RESTRICTS MOVEMENT LESS DURING DRINKING

(2) SOLDIER CAN SQUEEZE FLEXIBLE CANTEEN TO INCREASE DRINKING VOLUME AND SPEED

FIGURE 4. SQUEEZABLE CANTEEN WITH LONGER INLET TUBE

(L)

This is my U.P. concept in Binder H p. 21, marked "drawing #3077"

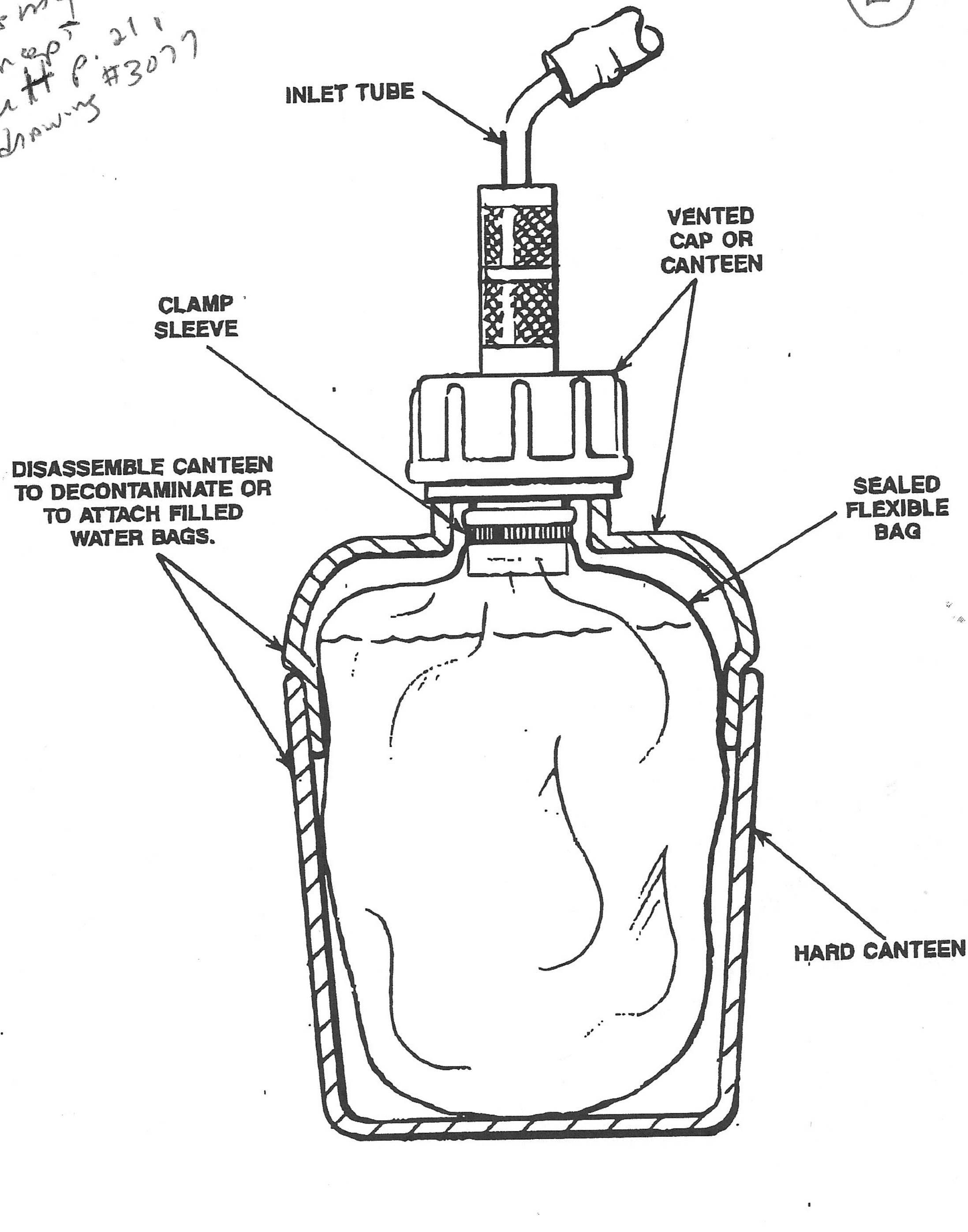


FIGURE 5. FLEXIBLE BAG DRINKING CONCEPT

(M)

The squeezable canteen (Concept D5) is shown in figure 4. In order to use the present drinking system, the soldier first blows air into the canteen. The air pressure in the canteen forces a small quantity of water through the drinking tube and into the soldier's mouth. This process can be slow. With a squeezable canteen, the soldier can speed the drinking rate because hand pressure forces water through the drinking tube faster. Permeability of the canteen material is an important consideration and should be carefully evaluated.

Figure 5 illustrates Concept D6, the collapsible bag inside a hard canteen outer protective shell. The objective of this concept is to reduce the probability of damage that may exist with the flexible (soft) material used for the squeezable canteen (Concept D5) described above. The collapsible bag could be designed to be filled through the canteen neck, or a filled bag could be snapped into the canteen neck from the bottom when the lower shell is removed. The collapsible bag allows the soldier to suck water from the canteen because air does not have to go into the water container to allow water to be withdrawn. However, air infiltration between the shell and bag is required. The collapsible bag would have to be made of an impermeable material to prevent entry of agent into the water. A foil-covered material may be a possibility.

WITHIN 1ST patent

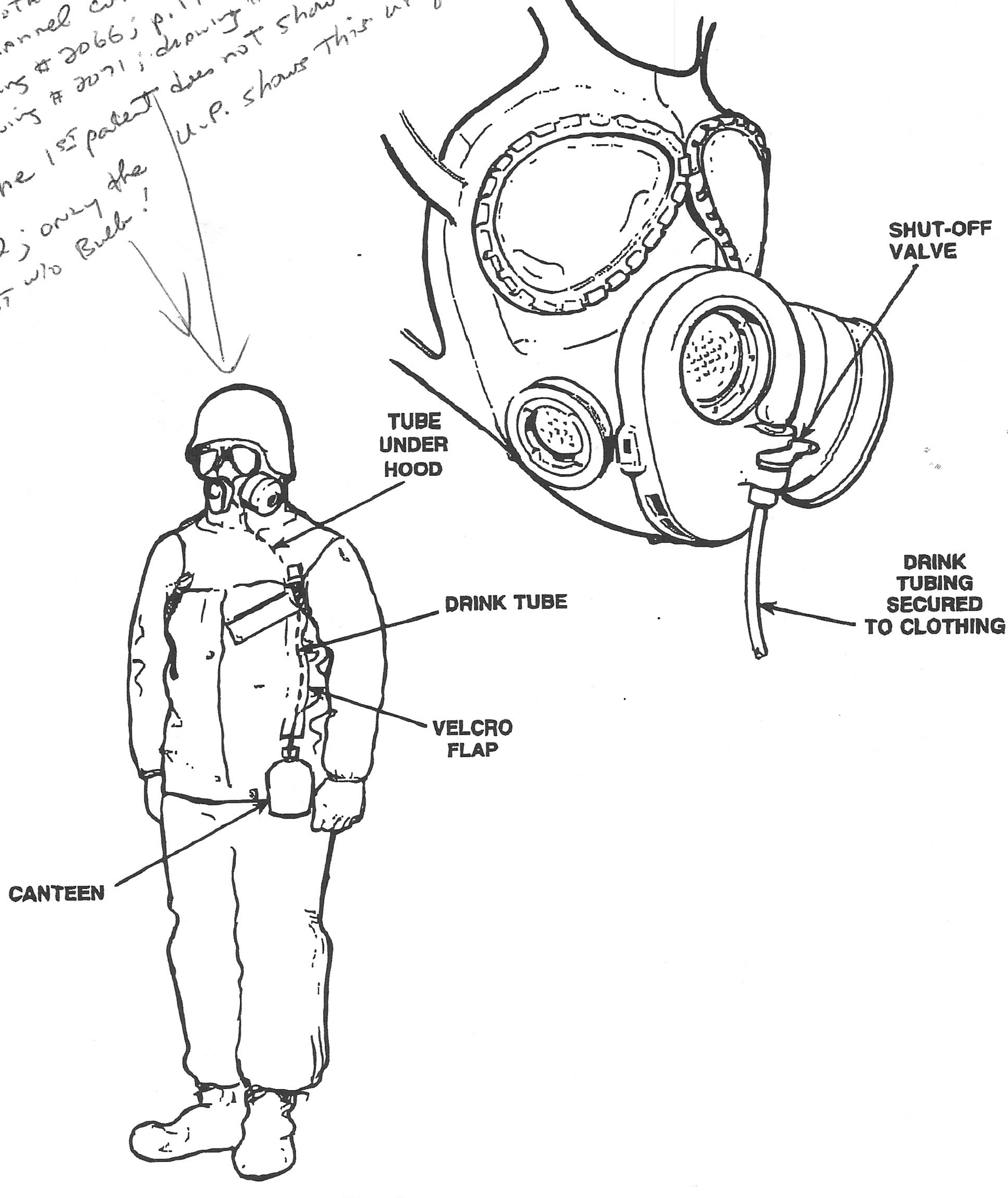
I submitted numerous sized samples of 1qt sized mylar bag constructions to NATICK

Concept D3 was rejected during the initial evaluation because of concern about the long drinking tube being damaged. However, figure 6 illustrates a conceptual arrangement that we believe is workable and should be considered. The inlet tube is routed under the hood and is enclosed in a protective flap to prevent damage. The tube is attached to a flexible canteen or a collapsible bag canteen. A shutoff valve at the mask is closed for safety when the soldier is not drinking. As an alternative to the lever-actuated valve (shown in figure 6), a spring-loaded check valve could be used. A button could be depressed to open the valve when the soldier is drinking. When the button is released, the valve automatically closes. When the canteen is exhausted it can be detached from the inlet tube, filled, and reconnected. For

not in patent in U.P.

Aprl '83
U.P. Binder I
p3 drawing # 2048 — under hood routing; p4 drawing #2049
view of both hood/velcro/sewn
jacket channel concealing drink tubing
p17 drawing # 2066; p.19 drawing #2068
p.20 drawing # 2071; drawing # 2084/#2085
NOTE: The 1st patent does not show a concealed drink tube — its exposed; only the U.P. shows this unique feature
This is First w/o Bulb!

(N)



POSSIBLE ROUTING TO CANTEEN
FOR SEMI-PERMANENT CONNECTION
OF DRINK TUBE TO CANTEEN

FIGURE 6. INLET TUBE PERMANENTLY ATTACHED TO CANTEEN

(O)

this concept, the placement of the canteen could be critical, because the effort required to suck water up the drinking tube may be prohibitive. Also, doffing and donning protective equipment would have to be considered. Also, doffing and donning protective equipment would have to be considered. It may be necessary to modify or reject the concept based on don/doff considerations or drinking ability after further evaluation.

After further analysis, Concept 5, the mirror (or polished metal plate) aid for reinserting the inlet tube in its protective pocket, has been rejected. Carrying the extra apparatus is undesirable. If the protective pocket is made larger, reinsertion of the check valve should be easier, thus reducing the need for the mirror. It may also be possible to place the protective pocket higher on the mask where it may be partially visible to the person wearing the mask.

It is recommended that all of the concepts illustrated in figures 3 through 6 be evaluated by conducting a detailed design or mockup effort.

3.7 Adding Eating Capability to the XM40 Mask.

The XM40 mask does not provide a capability for eating. Three types of food are possible, liquid, semi-liquid, and solid. Each of the three requires a different method for getting the food into the mask and ideas for all three were suggested during the concept generation session.

There is considerable disagreement with regard to how frequently nourishment is required. Dr. Ralph Goldman, Multitech Corporation (retired from a senior civilian position at Natick Laboratories), has stated to Battelle in a related effort that his understanding is that eating is not essential for periods up to 5 days and need not be considered for periods as short as 72 hours. However, under current requirements documents and concepts of operation, food must be available, and eating may be desirable psychologically to ease the boredom during inactivity.

Between '83-85 I submitted 3 of 4 recommended here before this report recommends them to CRDC. This report produced a contract annex for ICC Div. Nov 85 while I was told there was no need – get a requirements Doc from Chem Sch! – which took 5 years. In contrast, CRDC/ICC Div worked continuously on my original dual hose concept as a contract annex to satisfy the need to improve mask drink systems under the 1980 JSOR Doc. for the M40 mask series.