# APPENDIX B

BASELINE LISTING OF THE DTO/DSO HARDWARE NSTS-21096 (7/13/89)

(FLIGHT INTEGRATION MANAGER)

UPDATED SEPTEMBER 15, 1

| DTO / DSO | SUBJECT | 28 RAMEY | 34 DARNELL | 33 LEARY | 32 ELLIS | 36 TAYLOR | 31 BATES | 35 DARNELL | 37 BATES | LEARY 38 | 40 ELLIS |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DSO 0467 | INFLUENCE OF WEIGHTLESSNESS ON BAROFLEX FUNCTIONS | | | X | X | | | | | | |
| DSO 469 | RADIATION DOSE DISTRIBUTION | X | | | | | X | | X | | |
| DSO 473 | IMMUNE DYSFUNCTION DELAYED HYPERSENSITIVITY | | X | | X | | X | | | | |
| DSO 474 | RETINAL PHOTOGRAPHY | | X | X | | | | | | | |
| DSO 0901 | DOCUMENTARY TELEVISION | X | | | X | | X | | X | | X |
| DSO 0902 | DOCUMENTARY MOTION PICTURE | X | | | X | | X | | X | | X |
| DSO 0903 | DOCUMENTARY STILL PHOTOGRAPHY | X | | | X | | X | | X | | X |
| DTO 0329 | IWCS (IMPROVED WASTE COLLECTION SYSTEM) | | | | | | | X | | | |
| DSO 471 | AIRBORNE PARTICULATE MONITORING | | X | | X | | | | | | |
| DSO 477 | PRE AND POST FLIGHT MUSCLE PERFORMANCE | | X | | X | | X | | | | |
| DSO 472 | INTRAOCULAR PRESSURE | | | | X | | X | | | | |
| DSO 475 | MUSCLE BIOPAY | | | | X | | | | | | |
| DSO 476 | INFLIGHT AEROBIC EXERCISE | | | | X | | | | | | |
| DSO 478 | MEDICAL DSO | | | | X | | | | | | |
| DSO 479<br>DSO 450<br>DSO 463 | MEDICAL DSO<br>MEDICAL DSO-SALIVARY CORTISOL LEVELS<br>MEDICAL DSO-INFLIGHT HOLTER MONITORING | | | X<br>X | | | X | | | | |

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# APPENDIX C

Whitmore Enterprises
Diversified Systems Development

Specialized Equipment In Support Of NASA Space Program • Specialized Medical Research Devices
Development Of Alternate Energy Sources: Solar, Wind And Hydro-Electric

January 8, 1991

Mr. Bob Pineda
ILC Space Systems
16665 Space Center Boulevard
Houston, Texas 77058-2253

Dear Mr. Pineda:

This report documents some of the comments of the crew and our findings for the Whitmore IWCS 1-1000 which flew on the space shuttle Columbia (STS-35) in December 1990. While we were not requested to provide this information we believe it may supplement data research. This report will outline some of the observations which the crew noted about the functional aspects of the IWCS.

Our development effort for the month of December included further study of methods for inserting the bags into the IWCS EDO compaction chamber. While our study last month concentrated on issues in the current design, we are still studying alternative methods. For this reporting period, we are including a study of the Whitmore IWCS 1-1000 which flew on the space shuttle Columbia (STS-35) in December 1990. While we are not required to provide this information, we believe it may supplement your data research. This report will outline some observations which the crew noted about its functional aspects.

The equipment flown was the IWCS 1-1000, a manual crank compaction Improved Waste Collection System (IWCS). Built in 1984 by Whitmore Enterprises, Inc., this equipment was built as a demonstrator of the concept of a plunger compaction system. The unit was scheduled to fly on the January 1986 Challenger flight. However, delays caused the schedule to slip. When NASA scheduled the unit to fly in the middle of 1990, ILC was contracted to perform flight re-certification of the unit. We were subcontracted to perform refurbishment of the unit and to incorporate configuration changes. Delays in the shuttle mission schedule pushed the flight behind to the end of 1990.

Crew Debriefing at JSC

December 13, 1990 marked the crew debriefing at JSC. Representatives from Rockwell, Hamilton Standard Management Services, ILC and Whitmore Enterprises, Inc. were on hand to listen to the astronaut's comments. Comments were favorable for the unit. Only three issues surfaced which were of concern to the crew: 1) the unit was easy to rip loose from its Velcro mooring, 2) the wiper frame storage box was "in the way," and 3) it was

hard to tell the difference between used wiper frames and new ones. All these issues are functions of the temporary nature of the unit. Replies to questions were brief because of the short time frame for the meeting. The unit was set up on the sixth day of the mission and was used for two days for the duration of the mission. They recorded 16 uses (although we counted 18 frames used, meaning the IWCS was used 18 times). It was easy to set up and the hardware stowed in the airlock stowage bag was easily accessible. Since the IWCS was positioned in front of the port hatch, there was a question pertaining to any problems removing or installing the escape slide. There was no reported problem.

Air flow questions were asked next, since the WCS EDO is using a similar approach to separation. We believe this information may be of some benefit to Hamilton Standard's effort. Evaluation begins by determining the noticeable difference among the six air flow velocity settings from a user standpoint. Our as-built drawings indicate the hole in the top of the compaction chamber to measure as a 5.6" long by 4.9" wide oval. The seat stands at .35" above the top of the compaction chamber on four feet which are designed not to obstruct air flow. Referring to our notes, the settings based on these physical characteristics have been tested by ILC and are included here:

Setting 1: 16.7 Cubic Feet per Minute
Setting 2: 30.9 Cubic Feet per Minute
Setting 3: 45.9 Cubic Feet per Minute
Setting 4: 54.5 Cubic Feet per Minute
Setting 5: 58.5 Cubic Feet per Minute
Setting 6: 58.6 Cubic Feet per Minute

Glancing at these values illustrates little difference among settings four, five and six while the difference between one, two, three and four is an average of 12 cubic feet per minute. This accounts for the fact that little change was noticed by the crew when using settings five and six when compared to four. Another collective opinion suggested that settings one and two did not supply enough air flow to cause separation. Setting three was noted as sufficient for most separations, and seemed to be the setting which should be labeled as the minimum setting.

It was suggested, however, that a booster blast of air (or "turbo" as it was described) be available to the user. While setting three was deemed sufficient, it was noted that in case of problems it would be convenient to have a user-initiated and controlled blast of air to aid in problem separation. However, caution must be exercised to avoid causing fecal matter to be set into an uncontrollable spin or destination. No one setting seemed to cause too much turbulence, not did it cause problems affecting how fecal matter and wipes adhered to the sides of the compaction chamber. The flow of the waste toward the front of the compaction chamber worked well. These results explain a workable combination of air

flow and compaction chamber opening. This quality was remarked as being "a big improvement over the WCS" referring to the G.E. System.

Another plus was the method of disposing of wipes. When the users found that they could deposit their wipes in the compaction chamber as opposed to the "coffee can," they remarked that the IWCS, "...worked like a normal toilet." Depositing wipes in the IWCS was noted to be easier than depositing them in the can, as they were "sucked" in and did not float about because of the absence of turbulence within the compaction chamber. The only complaint was the lack of sufficient wet wipes. It seems the crew likes plenty of wipes and as such they ran out of their allotted amounts "because no one told them what their allotted amounts were." Of course, compaction could have been reduced in order to gain more uses per inch of compaction if fewer wipes had been used.

The seat design was comfortable and apparently sealed well. No problems with size or form were reported. Males were the only users of the seat. The best report for the system was the simplicity with which the IWCS operated. Even though this system is manual and required cranking action, there were no objections to this activity and it was observed as a "major improvement" over the G.E. WCS and accomplished all it was intended to probe. We believe the most important point made about the IWCS was that it did not require the use of the vacuum line for venting of odors in the compaction chamber. The crew reported that no odors were noticed from the IWCS. It was mentioned that there was the possibility that odors did exist, but by staying in such a small environment for that length of time one could become desensitized to odors.

Clean-Out at Hamilton Standard

Clean-out was performed at Hamilton Standard Management Services at JSC on December 19, 1990. The first tasks included noting the settings and any structural damage. It was noted that no odor was emitted from the IWCS upon unpacking the unit. The unit appeared to be unharmed. The next task was to expel the waste and note observations.

The end of the compaction chamber was removed and a clear viewing box was slipped over the end of the compaction chamber. Turning the crank started the waste ejection process. The compacted wipes and waste were measured at 4.75 inches compacted size for 18 uses. When the box and waste were removed from the compaction chamber, the waste grew in length to 5.25 inches. There was a small amount of space left between uses as observed through the clear box. This indicates to us that the compaction force could have been ~~increased, adding at least three more uses per inch depending on the volume of fecal matter. A torque-limiter was integrated in the crank to keep users from over compacting the waste.~~

increased, adding at least three more uses in the 4.75 inch space used. A torque-limiter was integrated in the crank to keep users from over compacting the waste.

The users cranked until the torque-limiter disengaged, signalling the end of travel and the end of compaction. It was determined that the limiter could have been adjusted to disengage at a higher torque value, thus enabling a higher force to be exerted on the plunger during compaction. There existed an over-ride detent option which enabled the users to over-ride the torque-limiter and apply more compaction force.

After the waste was removed and the compaction plunger retracted, a line of lint was noticed within the compaction chamber. This signalled the location of the last wipe and compaction. The distance of this line to the inside of the rear bulkhead corresponded to the 4.75 inch thickness of the compacted waste verifying the depth of the compacted waste for 18 uses. A sparsely scattered thin film of fecal matter was smeared on the three sides of the compaction chamber. Fecal matter was reported to have been blown forward and stuck to the sides of the chamber rather than floating aimlessly about.

The unit was scrubbed and delivered to our facility for more thorough inspection. The possibility that United Technologies/Hamilton Standard could fly their seat prototypes on the IWCS in a future flight for testing in the Zero Gravity environment was mentioned. This concluded our review of the IWCS flight and post flight comments.

Sincerely,

Henry B. Whitmore, President
Whitmore Enterprises, Inc.

HBW/aww

Enclosures (2)

# IWCS CLEANOUT

NOTES FROM DECEMBER 19, 1990 - Hamilton Standard Management Services (HSMS) - 9 A.M. - HSMS Clean Room

Met by Sam - Quality Control personnel from HSMS

Those Present:

| | |
|---|---|
| Hubert Brasseaux | NASA |
| Henry Whitmore | Whitmore Enterprises, Inc. |
| Steve Turpin | Whitmore Enterprises, Inc. |
| Bob Pineda | ILC |
| Richard Openshaw | Lockheed |
| Jeff North | Rockwell |
| Pete Canga | Hamilton Standard |
| Clean Room Technicians | |

9:15 A.M.

- Put on Bunny Suits.
- Slight odor from WCS.
- Put on Anti-Odor Masks.
- Unpack the unit.
- No power was connected to the unit at any time.

Observations after the unit was unpacked but before disassembly:

- Flow Control valve set on 6.
- Small amount of fecal matter on seat.
- Frame Box was bent inward at the front.
- 18 wipes were "used" (missing from the box); only 16 uses were recorded.
- Cap to electrical interface not screwed in stowed position.
- Fan switch was in the "on" position.

- One frame missing from storage Box, but was found in the IWCS.

DISASSEMBLY

- Turn Crank two turns to fully compact waste.
- Remove (2) 1/4-20 Socket Head Cap Screws.
- Remove (2) 10-32 Socket Head Cap Screws.
- Remove Bracket
- Remove (12) 10-32 Truss Head Slotted Screws.
- Remove Rear Bulkhead.

Notes:

- No contamination around edges at Compaction Chamber end.
- No contamination around face of Bulkhead.
- No contamination on end of Seal Plug.
- Fecal Matter is seen through translucent Seal Plug.

CLEANOUT

- No power was connected to the IWCS.
- Place clear box on end of Compaction Chamber, place the seam upright.
- Slide clear box right on the Compaction Chamber; there was no binding.

Now crank out the waste while counting the number of cranks and dimensions of waste.

| # of Cranks | Inches of Debris Beyond End of Compaction Chamber |
|---|---|
| 0 - 3/4 | Gets crank to "zero" (no slack) |
| New 0 - 1 | 1" - 2" kept creeping outward via spring expansion |
| 1 - 2 | 3" |
| 2 - 3 | 4" |
| 3 - 4.5 | 4.75" total length of debris. Piston is visible. |

- No seepage was detected. All fluids had been absorbed.
- Slight mold growing on feces.

Remove the Clear Plastic Box

- Some expansion of the debris occurred - from 4.75 (compacted) to 5.25".
- Feces were dispersed mostly at the sides and bottom of the clear box.
- Place Lid on clear box. Align Lid Tab with box seam.

OBSERVATIONS

- Fibers were stuck randomly on the translucent Seal Plug, but no signs of seepage beyond the plug to the Rear Bulkhead as noted above.
- Retract the piston all the way back by turning the crank.
- No fecal matter was observed on the top of the Compaction chamber.
- Fecal matter film was observed on the bottom and sides of the compaction chamber. Noticed a "line" on the sides and bottom of the compaction chamber defined by a thin film and fibers on side of the compaction chamber where debris block was last compacted.
- Valves were not plugged by feces.
- Remove the wiper frame and clean all removed parts.

REMOVAL

- Remove particle filter. Dust and list is observed. No fecal matter.
- Gaskets - Dust and line is observed.

January 4, 1991

IWCS DEBRIEFING
DECEMBER 18, 1990

NOTES OF MEETING - NASA/JSC - BUILDING 4 - 2 P.M. - OFFICE 3002

Five of the seven astronauts were present:

| | | |
|---|---|---|
| (*) | Vance Brand | Cdr |
| | Guy Gardner | Plt |
| | Mike Lounge | Ms |
| (*) | Hoffman | Ms |
| (*) | Parker | Ms |
| (*) | Parise | Ps |
| (*) | Durrance | Ps |

Also Present:

| | |
|---|---|
| Dr. William Thornton | NASA |
| Henry Whitmore | Whitmore Ent. Inc. |
| Steve Turpin | Whitmore Ent. Inc. |
| Bob Pineda | ILC |
| Hubert Brasseaux | NASA |
| Mary Cleave | NASA |
| Pete Canga | Hamilton Standard |
| Jeff North | Rockwell |

(*) Denotes astronauts present

General Comments:

- Day 6 at 10 hours = First use
- Most crew members used the IWCS 2 to 3 times.
- The lid disconnects from latch pin when retracting the plunger.
- One Wiper Frame was bent by attempts to remove it while plunger was compacting waste.
- This IWCS did not utilize a locker while the new EDO WCS uses three lockers.
- No odors were noticeable even when the IWCS was open when retracting the plunger.
- The crew did not have to use the vacuum vent to alleviate odors.
- When the crew observed the bottom of the compaction chamber they noticed a thin smear of feces located on the bottom of the chamber.
- Include Teflon coating on the compaction chamber to prevent scrape marks? No.

See the handout "IWCS Questions for STS-35" issued at the review for the following answers to those questions. The numbers correspond to the questions.

1) The IWCS was set up on day 6. Total of 18 uses were detected by the number of wiper frames in the box which had their wipes removed.

Velcro on floor did not work. The DTO was easily pulled loose from the velcro and tended to float about while crew was seated. It was noted as "being in the way" and "took up real estate".

2) No problems removing or installing the escape slide. It was easy to set up.

3 & 4) Air Flow control knob settings:

- Setting #2 Tissue paper sucked in.

- Setting #3 More than sufficient to bias feces up to the front, but not enough for consistent fecal separation in some cases.

- Need a "turbo" blast of air to separate feces effectively.

- Setting #6 did not cause turbulence or feces to tap the bottom of the users.

- There was smear on the bottom and the two sides. None was noticed on the top.

- Minimum of setting #3 is recommenced for suction of feces and wipes.

- Big improvement over WCS.

- Frontward flow is excellent.

- Wet and dry wipes were used.

5) There was not a lot of turbulence.
It operated like a normal toilet in that a user could dispose of used wipes much like he does on earth. The main point was that IT WORKED.

6) No problems disposing of tissues in the toilet. Lifting on the thigh bar was not a problem.
This was better than the Tissue Can currently used.

7) No resultant odors.

Note: Ratcheting of the crank and plunger was too loose. They used the override in some cases.

• Need to explore some way of determining which frames had been used and which had not. Looking in the top of the box reveals all the frames look alike.

• Some corners of some pads were pulled loose of their frames by the high pressure of air flow setting #6. This did not affect compaction and absorption.

8) No comments.

9) Was the urinal hose long enough? Yes - DSO was long enough for most uses.

10) Frame box was the only problem in that it was noted as "in the way".
Realization that this was a temporary test situation was understood.
"Do not need another proof of concept."

Contingency Hardware Operation:

No comment.

Female UAS Filling Operations:

No comment.

Male UCD Usage:

No comment.

IWCS Stowage Pouch (Called Body Bag):

1) Stowage Pouch was an improvement over the past.

2) Use for food trash.

Waste Management System

No Comment.

End of IWCS Crew Debrief.

# IWCS PROJECT RESPONSIBILITIES AND CONTACT LIST

| NAME | COMPANY | JOB DESCRIPTION |
|---|---|---|
| BOHANNON, JACKIE | NASA | CREW EGRESS SLIDE |
| BORNE, CHUCK | RSOC | CREW TRAINING/IWCS MCKUP |
| BRASSEAUX, HUBERT JR. | NASA | SSM |
| BROOKS, DAVE | NASA | CREW TRAINING |
| BROWN, TRAVIS | NASA | PROJECT OFFICE |
| DESTEFANNO, FRANK | RI/A | AIRLOCK STOWAGE BAG |
| ENGLAND, WARREN | BOEING | FEPC ENGINEER |
| FRANKLIN, PAUL | BOEING | ORIGINAL RELIA. ENG. |
| GILLEY, RICHARD | NASA | 9A MOCKUP |
| GRICK-AGRELLA, SHELLY | BOEING | DRAWINGS |
| HARVEY, GEORGE | ILC | RELIABILITY |
| JONES, SHARON | RSOC | CREW TRAINING |
| KETCHEY, JANIS | JOHN | SOFT STOWAGE PROVISIONS |
| KIRKLAND, BURL | NASA | GFE OFF. (SCHEDULE INFO.) |
| LARCHAR, SCOTT | LSOC | KSC ECLSS |
| MALECKI, RICK | NASA | PROGRAM OFFICE |
| MCALLISTER, FRED | NASA | |
| MENDEL, CHARLIE | NASA | COST, SCHED., PREV. SSM |
| MORLEDGE, JACK | LORAL/FORD | SAFETY |
| NUCHIE, ELIZABETH | LOCKHEED | MATERIALS |
| OPENSHAW, RICHARD | LOCKHEED | LOCKHEED SUPPORT TO SSM |
| PEREZ, GIL | NASA | RELIABILITY |
| PINEDA, BOB | ILC | IWCS ENGINEER |
| RANGEL, ED | NASA | A/L STOWAGE BAG SSM |
| THORNTON, BILL | NASA | ASTRONAUT SPONSOR |
| WHITMORE, HENRY | WHITMORE | DESIGNER/MANUFACTURER |
| WINKLER, GENE | NASA | E63 DEPUTY CHIEF |
| WITHEY, MIKE | ILC | ORIG. ILC IWCS ENGINEER |
| WRIGHT, GREG | BOEING | RELIABILITY |