EVALUATION OF PROTOTYPE ADVANCED LIFE SUPPORT (ALS) PACK FOR USE BY THE HEALTH MAINTENANCE FACILITY (HMF) ON SPACE STATION FREEDOM (SSF)

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JUSTIFICATION:

Evaluation of the prototype ALS pack which has been developed for the HMF. This pack will enable the Crew Medical Officer(CMO) to have ready access to advanced life support supplies and equipment for time critical responses to any situation within the Space Station Freedom.

OBJECTIVES:

1. **Evaluation of the design of the pack.**

   This will include evaluations of:

   - exterior design and function
   - access to individual sections within the pack
   - access to contents within each section of the pack
   - restraint of the pack to the patient restraint and mini racks
   - restraint of each section within the pack to the patient restraint and the mini racks.
   - positioning the pack at various locations
   - access to contents within each compartment for deployment and utilization

2. **Collection of comments for revisions to design of the pack.**

   - entire pack

- sectional compartments
- restraint mechanisms within each compartment
- restraint mechanisms for each compartment within the pack
- restraint mechanisms for entire pack

INFLIGHT TEST PROCEDURES (CHECKLIST FORMAT):

APPROACH:

Operators will deploy the pack and each compartment within the pack independently for evaluation. They will then simulate deployment of the pack for a medical emergency and evaluate function in a time critical scenario.

1. Pack deployment

   - deploy pack from mini rack
   - restrain to patient restraint
   - restrain to rack

2. Compartment deployment

   - removal of individual compartments
   - restrain each compartment to patient restraint
   - restrain each compartment to work surface

3. Equipment and supplies access

   - removal of individual items from within each compartment
   - utilize equipment in succession from compartment
   - deploy multiple items at a time from compartment and secure for ready access

4. Transport of pack

   - access to pack from racks
   - move through area with pack
   - restrain pack to floor
   - access pack and contents

PARABOLA REQUIREMENTS, NUMBER, AND SEQUENCING:

No special requirements for intervals and spacing between parabolas.

Parabolas 1 - 10
- Deploy pack from rack
- Restrain pack to patient restraint
- Restrain pack to mini rack
- Restrain pack to floor

Parabolas 11 - 20
- Restrain pack to worksurface
- Access internal compartments individually (remove and replace)

Parabolas 21 - 30
- Access internal supplies and equipment within each compartment
- Remove contents and replace

Parabolas 31 - 40
- Simulate actual time critical deployment of pack
- Removal of pack from mini racks
- Transport to sim area
- Restrain pack
- Restrain CMO
- Access contents of pack

TEST SUPPORT REQUIREMENTS (GROUND AND FLIGHT):

Space Required:
Full width of KC-135, and 10 feet of length

Load flight week:
Mini Racks:
- HMF Prototype Patient Restraint

Loaded on flight day:
- video camera
- ALS pack containing medical supplies

Power requirements: 110 VAC for patient restraint

DATA AQUISITION SYSTEM:

- In flight written checklist
- Self report post flight
- Video

MANIFEST:

Debra T. Krupa:	DK (KRUG)
Victor Kizzee:	VK (KRUG)
John Gosbee:	JG (KRUG)
Linda Murphy:	LM (MDSSC)

PHOTOGRAPHIC REQUIREMENTS:

- Non-dedicated still photography
- Video photography provided by examiners

PROJECTED RESULTS:

The safe provision of medical care for all portions of the Space Station requires that the HMF provide a means for rapid access and transport of life saving medical supplies. The ALS pack is required to fulfill this need. We hope to evaluate the current prototype design for function and performance, and then determine any needed alterations to the design of the pack. The size, shape, and form will be examined, as well as the utility. The placement of time critical medical supplies will be examined and decisions made as to placement within the pack or the racks at the HMF.

STRUCTURAL LOAD ANALYSIS:
See HMF Mini-Rack Experiment (1-24-90)

ELECTRICAL LOAD ANALYSIS:
See HMF Mini-Rack Experiment (1-24-90)

HAZARD ANALYSIS/SAFETY:

Potential Hazard: Loose items may float free from pack

Response: Only one item at a time will be deployed from the pack. All items will then be restrained for use. Items which become loose will be retrieved by a designated operator before they float free from the experiment area.

RESULTS:

Photography:

Stills:

The number and quality of stills received with this flight were substandard. A majority of the additional information was gained from review of the video tape and written comments.

S90-36477
The airway management kit of the pack is destowed by LM and opened by DK. Attempts at access to various areas within the kit are performed.

S90-36479
The airway management kit is velcroed to the work surface by the strips along the posterior spine of the kit and work is attempted without holding the kit in place. An endotracheal tube is removed by DK and handed to LM from within the kit. In the foreground the entire ALS pack is seen as opened and secured to the patient restraint.

S90-36483
The suction kit is deployed from within the pack and the mesh top unzipped by LM. The contents are exposed by DK.

S90-36485
The PASG bag is destowed, secured to the patient restraint, and then opened by DK. Upon opening, the length of tubing which had been coiled within the kit rapidly expanded and began to float away. It was grabbed by DK to contain.

S90-36488
Various kits within the pack are destowed by JG and LM. In the foreground, the IV section of the pack is secured to the work surface by the velcro strips along the posterior of the pack. LM is deploying the waste management kit. JG has deployed the HAL kit (right hand) and the assessment kit (left hand) from within the pack.

S90-36495
A photo of the internal contents of the ALS pack with each kit placed internally. LM is opening the zipper compartment located on the inferior surface of the face of the pack. DK is replacing the IV kit within the pack.

S90-36496
The face of the pack which has a large velcro strip for closure or securing is lifted and displayed by DK and LM.

S90-36499
The entire pack is secured to the face of the mini racks to assess zero gravity access in a possible intended deployed position. DK is positioned with her feet bracing her between the miniracks and the patient restraint for stability. The face of the pack is unzipped and dropped to allow viewing of the internal kits within the pack. DK has destowed a gauze roll and the intubation roll from within the pack and handed it to JG who is restrained to the MRS in the background.

S90-36504
JG is securing the pack to the front of the mini racks with interlocked D rings.

S90-36505
The entire pack and accessory transport equipment containers are connected by D rings and DK is attempting to move through the aircraft with the collection of equipment using the ropes as a translation aid.

S90-36506
A repeat of 36505 from the front view.

Video:

NASA master reference #903507. Video was reviewed by the experimenters. Quality was acceptable and provided excellent additional data. Observations from video are included in this report.

CONCLUSIONS:

This flight provided a very successful evaluation of the first prototype of the ALS pack for the HMF. It was able to evaluate various designs for containment, restraint, securing, deployment, restowage, and movement of supplies and groups of supplies.

Evaluation of the design of the pack.

Exterior design and function:

The exterior of the pack functioned well through all testing. The backpack straps of the pack were not utilized, as this type of securement is not required for ease of movement in microgravity. If the pack is to be used in a one gravity environment after return however, the backpack straps might become a useful item. If not, they are unnecessary. There should also be additional loops, or hooks to allow ease of access to rack restraint throughout the station.

Access to individual sections within the pack:

There were no difficulties with access to individual kits within the pack. The large open pack design allowed ease of access. The color coding and labeling of each kit were very useful in identification by the experimenters as to which kit was to be removed. The side pockets within the pack itself were very small and tight. If these are retained, they should be designed for specific items only, or should be removed. The interior surface of the pack being covered with velcro was very useful as a work surface. This allowed deployment of numerous loose parts and containment. The interior area of the flap of this pack was covered with potential securing mechanisms. The loops which held the cylindrical objects worked very well. The loops with the snaps were ideal to dispense tape. The loops around the tongue depressors did not function well. As one was removed, they all became free. The pocket with flat supplies contained worked well for access and restowage. It was felt however that this area should be used for other purposes, and for future packs should not contain the items that this pack did.

Access to contents within each kit:

Assessment kit (yellow bag)
Performed well. All instruments were held inside until needed. Velcro loops held the large bulky items well, and the bands held the cylindrical items.

Waste management kits(small navy kit with small orange kit inside)
It was a very good idea to place one kit within the other kit, within the other kit. This saved space, and there were no difficulties in deployment of the kits.

IV kit (long navy kit with mesh top, zipper opening and open interior)
Grouping of each set of supplies for the start of an IV into a bag within the kit seemed to work well. However, there was no way with this kit to deploy 3 - 4 loose items to allow a procedure to occur.

Airway/breathing kit (hot pink)
There was not an area of velcro to restrain this kit to. It was difficult to hold the kit open to maintain access to the interior. A bungee cord was used to hold down the kit for evaluation. Each of the items within the kit were held inside well without coming loose. Items which were held in place by elastic straps required two hands to access/restow. The pockets with the velcro tops also required two hands, but appeared to secure items well. The mesh covering allowed easy identification of items.

Roll
The roll seemed to work well, however it needs to be designed around the supplies which will be included within it. The tape roll which was placed within the velcro loop came loose, and should be possibly placed within a snap loop. It proved to work well for dispensing tape to have it in an apparatus which allowed "loose rolling". The corners of the roll were difficult to contain and secure. Clips were used, and each end folded down to allow securing. Each corner of a roll will have to be secured. The pouches on the sides with netting were very useful. Rolling the kit back up took both CMOs. This may have been due to the kit not being designed with the equipment it contained. However, this difficulty should be avoided.

Drug kit (orange bag with cards)
The large amount of velcro on the back held this kit in place well. This needs to be available on both sides of a kit which zips open on three contiguous sides. It was very easy to move the syringes in and out of the tight loops with one hand. It occasionally took two hands to replace.

Light green kit with miscellaneous supplies
This kit held to the work surface well. Upon shaking and jostling the kit, there were no dislodges of contents. The lid was that of two zippers (one down either side), and this proved to constantly get in the way once the kit was opened. A method for restraint of the lid should be provided. Items

which were a tight fit were difficult to get in and out. Some of the loops were too loose or too long for items, and did not hold the securely. The card concept worked well, but the exterior design of this kit did not work well with the interior design.

PASG bag (orange bag)
Upon destowage, the tubing of the PASG became a projectile and leaped out of the container. Both CMOs had to race to grab sections of the equipment before it floated away. Upon restowage, the tubing was uncontrollable, and frequently hit the experimenters in the face. (It was comparable to attempting to stuff one of those spring/coil snakes back into a peanut can.) There should be some sort of design for a coil on a card mechanism to destow and restow this heavy tubing.

Oxygen tank case
The tank easily slides into and out of this design. The case was easily attached to the pack bottom, but was too loose to allow coordinated movement of the entire collection.

Restraint of the pack to the patient restraint and mini racks:

Restraint to the patient restraint
The pack was secured to the patient restraint with buckle straps and bungee cords. It was recommended that there should be better and firmer tie downs for the entire pack. It made the pack very immobile to have it restrained well to the MRS, and this would not be possible if there were a patient on the MRS. The pack is so large that it appears to be a better option to secure it to a pole or the rack front.

Restraint to the mini rack front
The D rings at the four corners of the pack allowed for fairly quick attachment to the rack front. This did not hold the pack tightly enough for it to be used as a work surface, but it did allow an adequate access surface for interior kits. After the pack was opened, there was no method of securing the flap and it tended to float up in the way. Upon opening the pack, a loose roll of tape floated out. It had been restrained with a velcro strip. Arm boards also floated out which had been placed in the pockets on the side of the pack. All CMOs agreed that mounting the pack to the rack front was the preferred method of deployment for the pack. This allowed easy removal and restowage of kits. The kits not in use remained secure within the pack due to the interior of the pack being covered with velcro. These all remained in place with attempts by the CMO to jostle them loose.

The only difficulty was in closure of the front flap of the pack. It required two hands and proper positioning of the CMO for bracing between the rack and the MRS. It was possible to do, but difficult. This should be avoided in future packs.

Restraint of kits to the patient restraint, and work surface:
Those kits which had large areas of velcro were much easier to secure to the work surface. It was difficult to match up the various shapes of velcro strips with work surface velcro strips. The spread out strips did not keep kits secured when items were deployed from within the kits. A large area of velcro to deploy the kits to is required. This could be provided by an additional area or use of the inside of the main pack flap. This will be very important for use the pack away from the HMF where there may not be an available adequate work area. Any large items within the kits or pack could be secured to the work area by velcro strips which would wrap around them. Rolls or cards deployed from the kits would be attached directly to the work area. If velcro is not desirous, the kits should have some method of secure attachment which will allow the CMO to access interior compartments and remove supplies without the kit becoming loose from its restraint.

Positioning the pack:
During this flight the pack was mounted on the front of the racks in a very low position. This should not be done on the space station. This position caused great difficulty in positioning the CMO to provide access to the contents of the pack. The pack should be mounted within arm reach (in any direction), of the CMO as they are restrained to the MRS. We placed one CMO down in an area as to allow access to the pack, and had them pass contents to the other CMO. Placement of the pack for rapid access for repetitive procedures is paramount, as this pack is designed to aid the CMO through life saving steps which are very time critical. We highly recommend rack mounting the pack, however not in an out of reach position.

Transport of the pack and possible accessories:
In an attempt to simulate transport of the pack and possible accessory items to a remote location within the station, all pieces were connected together with existing D rings and clips. This connection of separate units made them very difficult to control. All of the pieces need to be secured together to prevent each floating separately. The collection was easy to move around, and size was not a problem. Pulling the collection was much easier than pushing it along in front. A pole might prove to be a useful tool in this scenario, as when you arrive to where you are moving the collection, you

must have somewhere to place all of the packs. As these individual units are attached, the securing mechanism cannot interfere with the access to equipment in the main pack.

RECOMMENDATIONS:

An overall comment from each of the experimenters was that the ideal pack will be designed around the specific equipment to be contained within each kit. This will allow greatest access, conservation of stowage, ease of restowage, and confidence in usage by the CMO.

1. The entire bottom of each kit within the pack should be velcro as to allow better securement upon deployment.

2. Each kit with a flap which opens upon access should have a method for securement so as not to interfere with equipment access. This also includes the flap of the pack itself.

3. The interior of the pack and the flap should be covered with velcro to allow immediate access to a work surface. All examiners felt very strongly that the interior area covered with velcro worked very well.

4. The entire pack is so large that is should be restrained to the surface of the HMF or adjacent racks rather than the MRS. It should be restrained in an area of a rack which will allow easy access, i.e. not down too low or out of reach from where the CMOs are restrained with the patient.

5. The capability for securing the entire pack to a rack anywhere within the SSF is required for emergency deployment. The mechanisms for securing the pack are in need of further examination.

6. Transport equipment must be capable of securing together adequately to allow ease of movement. Pulling the pack was much easier than pushing the group. The pole or some similar method for coordinated movement should be pursued. This method cannot interfere with access to any segment of the pack for access.

7. Evaluation of various shapes and types of zipper openings should be performed. Openings which produce a long flap of material, must be secured. A U shaped zipper was suggested for evaluation.

8. Top flaps of kits should open such that practically the entire top of the kit is exposed. Items which are secured under a corner or strip of material are difficult to access (required two hands). Packs with one zipper in the center required two hands to access items - one to open and separate the halves of the kit and another to access the supply.

9. The roll provided the easiest access to equipment. The size of the roll should be no larger than the work surface area available to secure it upon. Each corner of the roll should have some method of securement. The roll should be designed around the equipment which will be placed within it, and the equipment should be placed in order of operational requirements. The roll should be designed as to allow one CMO to re-roll.

10. Stiffened cards should be evaluated. These could be backed with velcro to secure to a work area, or function as the work surface for other supplies. These might be designed as a "book". This method appears to work well for small items.

11. The use of mesh/net for covers of containment areas works well and should be maximized.

12. Elastic bands for containment of cylindrical items works well for one hand deployment or restowage.

13. Velcro strips which secure around large or odd shaped items works very well.

14. Placement of the waste containment kits one within the other worked well, and saved a large amount of space.

15. The IV kit should contain separate sections with all supplies for each IV start.

16. Pockets, if used at all, should not be deep.

17. See through fabric should be used as much as possible.

18. The pockets on the sides of the current prototype are too tight. If they are retained, they must be made somewhat looser.

19. When zippers are used, they should be easy opening (not sticking).

20. Numerous small items should not be placed within a pocket or container. If one is removed, they all float out.

21. The design of the drug kit (book with bands) worked very well and should be evaluated for other applications.

22. The PASG must be secured within its container as to allow controlled deployment and access. Possibly evacuation of some type of surface to coil the tubing around.

23. If the pack is mounted to the front of the rack, it should be secured tightly, and placed in a position to allow body level access. This position was preferable for access to the pack.

24. The backpack straps are not useful in microgravity and are not required for the pack.

25. The coding with bright colors of each kit was very helpful and is highly recommended.

26. Loops were very functional for access to rolls of tape. Snap loops appeared to function better than velcro ones.

27. Design of kits should allow for ease of access to all areas within the kit upon opening. Those kits which had a center zipper only did not allow for ease of access to all areas of the pack. (see hot pint kit)

28. If the use of velcro to secure kits to a work surface is not possible, the method of securing the kit has to allow for the CMO to access supplies within all areas of the kit, remove them, and the kit not become dislodged from its restraint.

29. A future flight with an actual operational use of the pack in an end to end deployment, transport, securing, access, and restowage will be required after further refinement of the prototype. (sometime in FY 92).