Orbiter Crew Compartment Integration-Stowage

- Orbiter Crew Compartment Integration (CCI)
  - Analytical Integration - Planning the Orbiter CC configuration for ascent, on-orbit ops, and return
  - Stowage
    - Payload/GFE/FCE/CFE Hardware installations
  - Crew Compartment Configuration Drawing
  - MIP, Interface Control Annex-Manifest (NSTS 21000-IDD-MDK interfaces)
  - Plug-in-Plan and Cable routing (Photo/TV-Laptops-Power)
    - Crew Compartment Avionics Interface Tool (CCAIT)
Orbiter Crew Compartment Integration-Stowage

- Orbiter Crew Compartment Integration (CCI)-Stowage
  - Implementation of SSP and ISSP manifest requirements within Orbiter SSP constraints/capabilities.
  - Configuration drivers:
    - Changes in Space Shuttle Mission-Deployable Satellites, Spacelab science, SpaceHab, MIR/ISS (transfers and crew rotation), and HST repairs
    - Differences in Orbiters
    - Technology evolution of Orbiters and hardware-Laptops, Photo/TV, ACES
    - Satisfy engineering requirements for SSP/ISSP hardware installations/stowage
    - On-orbit Shuttle/Crew operations-Habitability
    - Transfer operations between Orbiter and MIR/ISS
    - Ferry Flight configurations for landings at alternate sites
  - What works
    - The Crew Compartment Integration process including pre-pack physical integration in Houston to installation in Orbiter at KSC.
      - Excellent communication and team work.
      - CCI team has responsibility and control per NSTS 07700 vol. IV, Bk1 and CoFR NSTS 08117.
    - Orbiter mass property envelopes allow analytical integration without unique analysis- “stay in the box” go fly.
Orbiter Crew Compartment Integration-Stowage

• Orbiter Crew Compartment Integration (CCI)-Stowage
  – Available Orbiter volume:
    • 127.5 Middeck Locker Equivalents (MLE) (OV-104/OV-105, OV-103 125.5)
    • Orbiter volumes, Middeck lockers, stowage bags.
    • Actual stowage volume available dependent on mission requirements-Shuttle forward CG or Ascent Performance Margins
  – Requirements:
    • Core set of hardware for 5 CM/ 7Days- food, clothing, Hygiene, LiOH, IFM tools, Laptop computers, Photo/TV, navigation aids, EMUs, EVA tools
    • Above Core mission requirements
      – Rendezvous and docking- Range finders, Binoculars, Centerline Camera
    • Addition GFE hardware requirements/evolution of technology
    • Payload requirements (ISS MKD/HST)

MLE: Middeck Locker Equivalent/2.0 cu ft.
Orbiter Crew Compartment Integration-Stowage

• Orbiter Crew Compartment Integration (CCI)-Stowage
  – Orbiter Stowage (typical mass constraint= 30#/ft³):
    • Volume 3 B (ET tank photography)
    • Light Weight Middeck Accommodation Rack (MAR)- 6 MLE
    • Waste Management Compartment- Hygiene
    • Middeck Lockers: Single, Double
    • Trays: single, double
      – Orbiter CTB’s: single, Half CTB’s
    • Middeck Aft (Ditch)/Ext. A/L Bags (5 MLE/10 MLE)
      – (ISS Double, Triple CTB’s, MO2, MO3)
    • Aft Flight stowage containers, volumes (A16 and A17)
      – External Airlock installation of two EMU’s

MLE: Middeck Locker Equivalent/2.0 cu ft.
### Evolution of Orbiter Crew Compartment Stowage volume

<table>
<thead>
<tr>
<th>Volume Name</th>
<th>First Flight</th>
<th>Stowage volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA9N Stwg. Bags (3)</td>
<td>STS-44 (11/91)</td>
<td>1.50 MLE</td>
</tr>
<tr>
<td>Middeck Accommodations Rack (MAR)</td>
<td>STS-49 (5/92)</td>
<td>6.00 MLE</td>
</tr>
<tr>
<td>Lockers MA9D / MA16D</td>
<td>STS-49 (5/92)</td>
<td>2.00 MLE</td>
</tr>
<tr>
<td>Extended Volume B (N/A on OV-103) approx.</td>
<td>STS-49 (5/92)</td>
<td>4.00 MLE</td>
</tr>
<tr>
<td>Volume D (N/A on OV-103 or with RCRS)</td>
<td>STS-49 (5/92)</td>
<td>4.00 MLE</td>
</tr>
<tr>
<td>EDO LiOH Box (available only with RCRS)</td>
<td>STS-50 (6/92)</td>
<td>3.50 MLE</td>
</tr>
<tr>
<td>Aft Flight Deck Stwg. Cont.s (CCCD concept)</td>
<td>STS-50 (6/92)</td>
<td>0.75 MLE</td>
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<tr>
<td>Volume 3B</td>
<td>STS-58 (10/93)</td>
<td>2.00 MLE</td>
</tr>
<tr>
<td>Internal A/L Ceiling Bag</td>
<td>STS-62 (2/94)</td>
<td>4.00 MLE</td>
</tr>
<tr>
<td>Seat 6/7 Stwg. Bag</td>
<td>STS-74 (11/95)</td>
<td>3.00 MLE</td>
</tr>
<tr>
<td>ODS Stwg. Bag</td>
<td>STS-76 (3/96)</td>
<td>5.00 MLE</td>
</tr>
<tr>
<td><strong>Airlock out MDK Stwg. Bags (OV-103,104,105)</strong></td>
<td><strong>STS-82 (2/97)</strong></td>
<td><strong>40.00 MLE</strong></td>
</tr>
<tr>
<td>Lt. Wt. MAR</td>
<td>STS-96 (5/99)</td>
<td>N/A</td>
</tr>
<tr>
<td>Lt. WT. Lockers</td>
<td>STS-103 (12/99)</td>
<td>N/A</td>
</tr>
<tr>
<td><strong>Total volume increase</strong></td>
<td><strong>(151.5 cu. ft.)</strong></td>
<td><strong>75.75 MLE</strong></td>
</tr>
</tbody>
</table>

1 MLE equals approximately 2 ft³
Crew Compartment Photos
Orbiter Crew Compartment Integration-Stowage

Volume B and EDO version Vol B
Fits curvature of Orbiter wall for addition ascent on-orbit stowage volume only
Orbiter Crew Compartment Integration-Stowage

Under Floor Volumes

Volume D (4 MLE) restricted access

Volume F (4 MLE) Wet Trash

Volume G
Contingency Hygiene
Orbiter Crew Compartment Integration-Stowage

Middeck Lockers and Trays

Middeck Aft Lockers

Double MDK Locker Tray
Approx. net 0.8 ft³

MA9N bags- 3-stowage bags
to fit curvature of Orbiter
STBD wall
1/2 MLE ea.

Middeck Forward Lockers
Lt. Wt. MAR, Galley, Lockers,
Payloads, seats
Orbiter Crew Compartment Integration-Stowage

Post Landing View- Aft Middeck Stowage Bags
Crew re-packed on-orbit

2- 5 MLE Bags STBD FL and 2- 5 MLE Bags Port FL
(4) Ceiling 5 MLE Bags

8 Total 5 MLE bags available in the Middeck Aft
Orbiter Crew Compartment Integration-Stowage

Miscellaneous Middeck Stowage

Middeck Retention Net
On-Orbit stowage and limited return stowage
Looking Forward STBD

Dry Trash Bags
For on-orbit use only

EMU stowage in the Middeck

Sleep restraints, Ergometer Shoe Bag
Middeck air ducts
Looking STBD
Orbiter Crew Compartment Integration-Stowage

Miscellaneous Stowage

Aft Flight Deck L10 Stowage Containers
3/4 MLE each

WMC
Aft wall and Port wall stowage

Volume 3 B
Approx. 4 MLE
Orbiter Crew Compartment Integration-Stowage

On-Orbit Stowage/Habitability

Orbiter Middeck looking STBD/FWD

Orbiter Middeck looking Aft at 576 bulkhead hatch

Orbiter Middeck looking FWD/STBD
Orbiter Crew Compartment Integration-Stowage

On-Orbit cable routing-Crew situational awareness

Orbiter AFD looking STBD STS-116 left STS-112 right
Orbiter Crew Compartment Integration-Stowage

On-Orbit Single Logistics Module
STS-116/13A.1

ISS MO3 Bag- approx 10 MLE
Orbiter Crew Compartment Integration-Stowage

Launch/Return Middeck Configuration
Advanced Crew Escape Suits (ACES)
Provides O2/COMM and Individual Cooling (water)
Orbiter Crew Compartment Integration-Stowage

Orbiter Vertical Installations at the Pad
Stowage considerations for Vertical launch vs. Horizontal for landing

Emergency Egress
Net/Closeout, Av. Bay 3A
MDK Lockers, Escape Pole

MA9N bags, Av. Bay 3A MDK Lockers, GSE platform
Orbiter Crew Compartment Integration-Stowage

Misc. hardware stowage

Typical CTB packing designed by the Crew Compartment Integration Team for transfer to ISS Mini Cell, Pyrell with NOMEX cover

IELK (Soyuz Seat Liners) Crew Rotation 5 MLE bag each

5 MLE Bag with EMU LTA's
Orbiter Crew Compartment Integration-Stowage

Translation fit-checks between Orbiter middeck-Ext. A/L- ISS PMA
Orbiter Crew Compartment Integration-Stowage

Considerations for avionics bay Middeck Locker
interface structure movement.
Pressure Vessel “oil canning”
Ground vs On-Orbit vs 10.2 for EVA’s

Middeck looking forward at MF43C/E
PGBA Dbl. Size Middeck payload on
STS-113/11A
Transferred from ISS to Orbiter
Questions/Answers