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The Negatively Pressurized Conex (NPC) Program – How Acquisition and Systems Engineering Agility Delivered Capability to USTRANCOM in 95 Days



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Negatively Pressurized Conex (NPC) and NPC Lite (NPCL) BLUF



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The NPC & NPCL were developed under the USTRANSCOM JUON TC-0003 to meet the need for High Capacity Airlift of COVID-19 passengers. Both systems were designed, developed, produced, underwent testing (biocontainment, operational utility, and electromagnetic interference), and were fielded for operations in less than 100 days. The first NPC mission was flown 95 days from JUON issuance.



...As of today, 56 of 60 Systems have been delivered and are fielded and operational globally. Over 70 missions have been flown saving over 330 lives...



Agenda



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- The Problem
- Overview of the Systems
- The Program Plan
- Rapid Acquisition and Engineering
“Test, Fix, Test Approach”
- Lessons Learned



USTRANSCOM JUON TC-003

- **USTRANSCOM** and **AMC** identified the need to move up to 4,000 COVID-19 infected patients per month, both ambulatory and litter
- **JUON TC-0003** included the requirement for a solution capable of high capacity transport for infectious personnel from worldwide locations to both CONUS & OCONUS locations for quarantine and/or treatment
- Existing materiel solutions did not meet the isolation or high capacity requirements of USTRANSCOM





Background



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Joint Urgent Operational Need TC-0003, High Capacity Airlift of COVID-19 Infected Passengers – 28 Mar 2020

- Mission Description: The DoD requires the ability to **move a large number of COVID-19 infected personnel from worldwide locations to both CONUS and OCONUS designated locations for quarantine and/or treatment.** Many world-wide locations do not have the facilities, capacity, ability, and/or political will to provide the necessary level of care to personnel infected with COVID-19. This is acutely true in theaters where active combat operations are taking place. Furthermore, removing infected personnel from the theater reduces risk to the remaining forces conducting combat operations. **Protection of mobility aircrews and aeromedical evacuation personnel from contraction of COVID-19 while transporting patients infected with the virus is critical** in maintaining USTRANSCOM's readiness for Unified Campaign Plan assigned missions and the viability of the Joint Deployment and Distribution Enterprise.

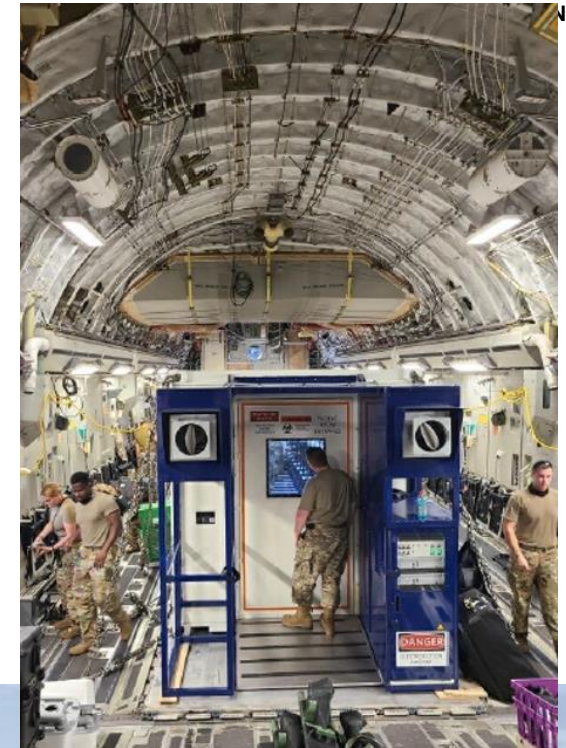




Overview of the Systems



	NPC	NPCL
Form Factor	40' Steel Conex	Custom 24' Aluminum
Passengers/Patients	30/22	16/14
Missions / Patients Flown*	60+ / 260+	10+ / 70+
Intended Use	Inter-theater	Intra-theater
Certified Airframes	C-17	C-17, C-130 (6 variants)
Systems Delivered / Planned	(30 / 30)	(26 / 30)



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U.S. AIR FORCE

Anteroom and Patient Entrance



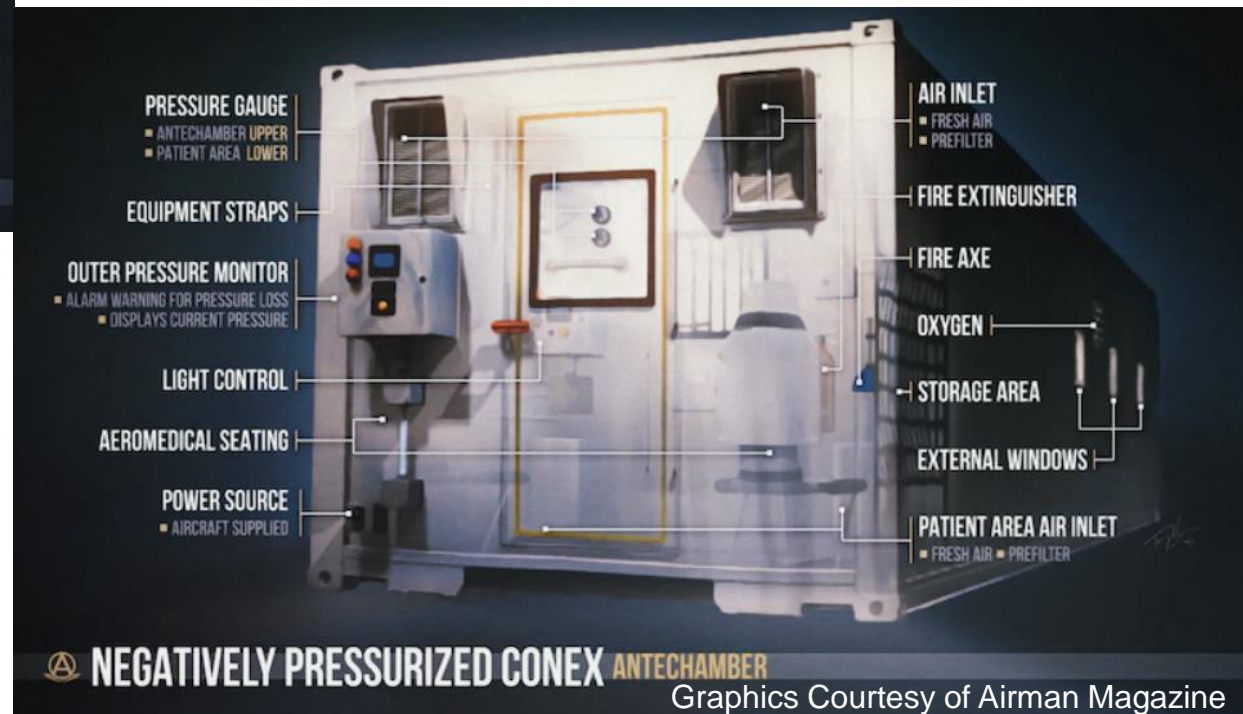
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Graphics Courtesy of Airman Magazine



Anteroom: Entry and exit for caregivers only. Location for don/doff of medical PAPR or other equipment. Upon exiting, a caregiver must remain in the anteroom and wait for the air to purge to allow for a clean environment and safe exit to the aircraft cargo bay. Alarm and Alert Lights Included for communications in/out of NPC

- **Patient Room:** Location where all patients will remain for duration of flight. All patients ingress/egress through the patient door, not the anteroom.
 - Hygiene station and sharps container
 - Two latrines (NPC), 1 latrine (NPC-L) each with a privacy curtain and additional toilet waste storage tanks.
 - Oxygen ports compatible with the NPTLOX and C-17 for use of aircraft medical grade oxygen



Graphics Courtesy of Airman Magazine

NPC Specific Features

- **A modified 40' CONEX, mounted on a pallet train & tied down**
- **Hosts 30 seats, configurations capable of care for 22 ambulatory patients, up to 8 litter patients or 30 passengers**
 - 30 C-17 side facing seats with paratroop extension. Each seat has been modified to include a side net with head catch and a 4-point harness to meet safety requirements
 - 5 litter stanchions each with 3 sets of litter arms and power outlets to handle necessary equipment power load
 - The 5 litter stanchions equate to 15 litter positions: the top position used to hold medical equipment, and the 5th litter stanchion used as an emergency litter for declining patients





NPC-L Specific Features



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- **Structure is aluminum, constructed as a 463L palletized system eliminating the need for tie down chains**
- **Hosts 16 seats, capable of care for 14 ambulatory patients (plus 2 caregivers) and up to 2 litter patients**
 - 16 C-17 side facing seats with paratroop extension. Each seat includes the same safety modifications as NPC
 - 2 litter stanchions each with 3 sets of litter arms and power outlets to handle necessary equipment power load (1 litter stanchion is an emergency litter for declining patients)





How We Got There



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- The Right Team
- The Right Plan
- The Right Agreement (Contract)
- The Design
- The First Proof of Concept (We Learned)
- Rapid Production and Testing
- Fielding



How We Got There The Team of Teams



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INTERDEPENDENCIES

LEGEND

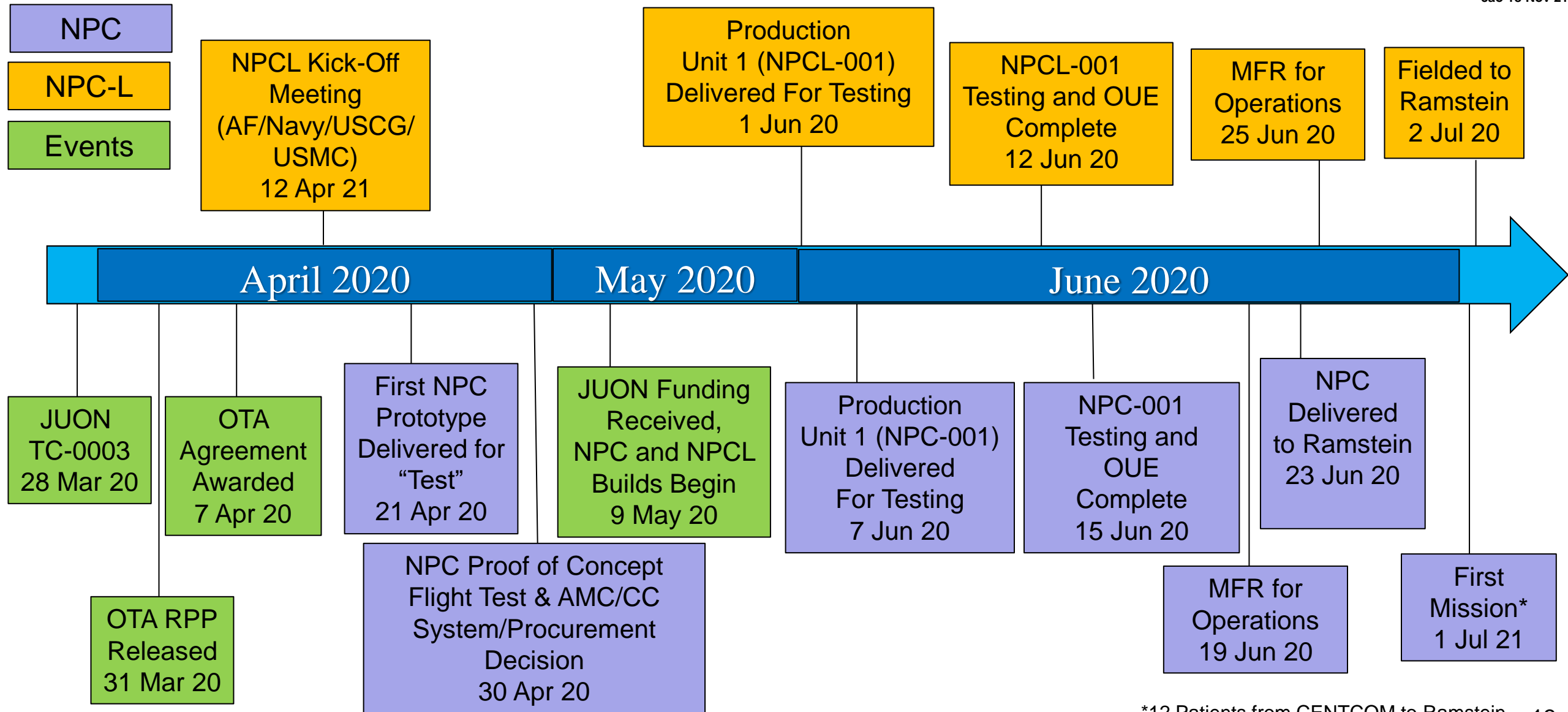
- 28 TES 28th:** Test and Evaluation Squadron
- 437 AW:** 437th Airlift Wing
- AE:** Aeromedical Evacuation
- AFLCMC/WNU:** Human Systems
- AFOTEC:** Air Force Operational Test and Evaluation Center Detachment 2
- AMC/A3T:** Air Mobility Command Aircrew Training Division
- AMC/A47:** TBD - info to come
- AMC/CC:** Air Mobility Command Commander (*why 2 c's*)
- AMC/SG CCAT:** Air Mobility Command Surgeon General Critical Care Air Transport
- AMC/TE:** Air Mobility Command Test and Evaluation
- ATTLA:** Air Transportability Test Loading Activity Office
- C-5:** C-5 System Program Office
- C-17:** C-17 System Program Office
- C-130:** C-130 System Program Office
- JPEO CBRND:** Joint Program Executive Office Chemical, Biological, Radiological and Nuclear Defense
- CBRN JPM P:** Chemical, Biological, Radiological and Nuclear Joint Project Manager Protection
- PEO ACS:** Program Executive Office Agile Combat Support



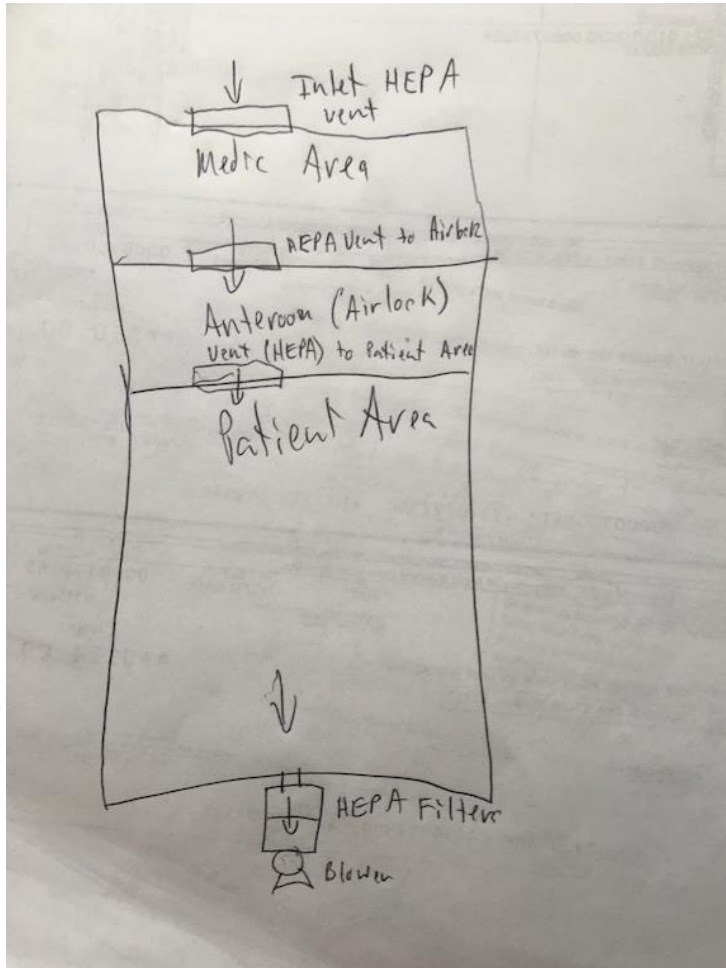
Joint USAF



Timeline: Concept to Operations in 95 Days



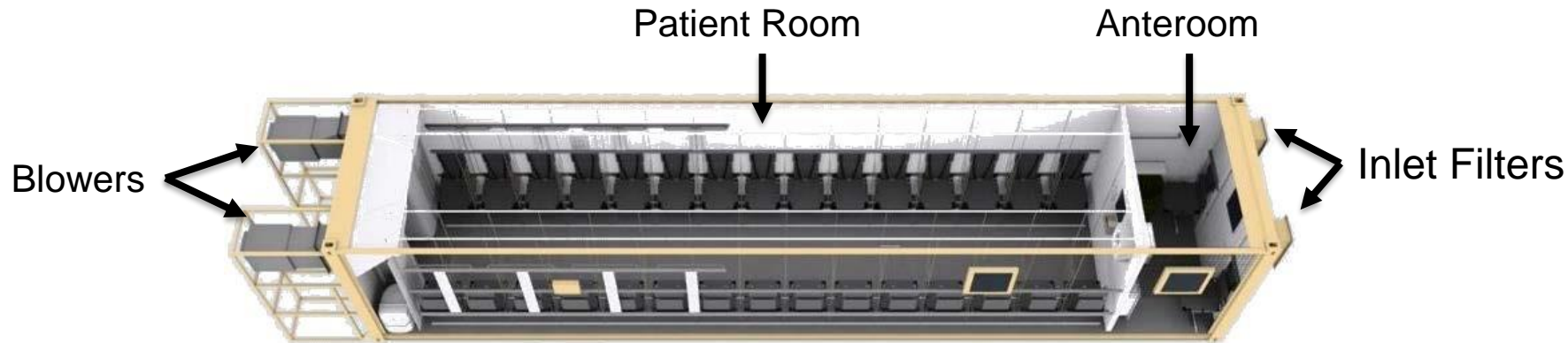
The Approach



- **Some Assumptions:**

- 40 foot shipping containers already certified for use on C-17 aircraft, readily available, and inexpensive
- Production of the NPC would be an integration challenge versus a new development challenge
- Current C-17 Sidewall seats could be easily integrated into the NPC
- COVID-19 was an urgent threat and speed was prioritized
- We could develop the NPC (and NPCL) to be “Airworthy By Design” – so the actual Airworthiness Process would be smooth

Negatively Pressurized Conex Theory

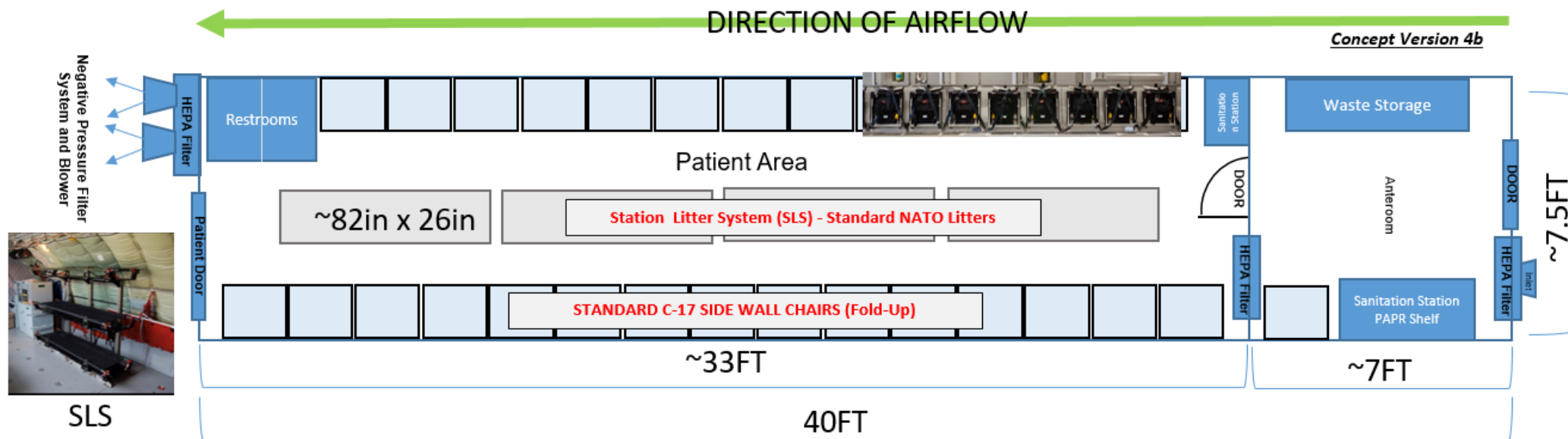


- Biocontainment: A single blower is used to create the negative pressure with a second one as backup. Air enters through two HEPA filters into an anteroom, then through two HEPA filters entering the patient room, followed by two HEPA filters out into the cargo compartment.
- Operational: Aeromedical providers ingress/egress the NPC via the anteroom. Aeromedical providers will dawn/doff their PAPR system in the anteroom. The anteroom acts as an airlock system that purges itself through the system when Aeromedical providers egress from NPC.

Initial Prototype(s)

- **Development of the NPC Proof of Concept:**

- Requirements were built based upon user input of the AMC/SG, AMC/A3, AMC/A5, AFRL CSTARS, DEVCOM CBC, AFOTEC, as well as engineering inputs from JPEO JPM-P, C-17 SPO, AFLCMC/EN, 711th HPW, and AFRL.
- The first NPC proof of concept prototype underwent testing at Joint Base Charleston (JBC) in which changes and user feedback were recorded and applied to the first production unit, NPC-001.
- To meet the intra-theater mission needs, an additional smaller variant to fit the C-130 (most variants) was required. With the flexibility of the OTA, the NPC-Lite 001 prototype was added.



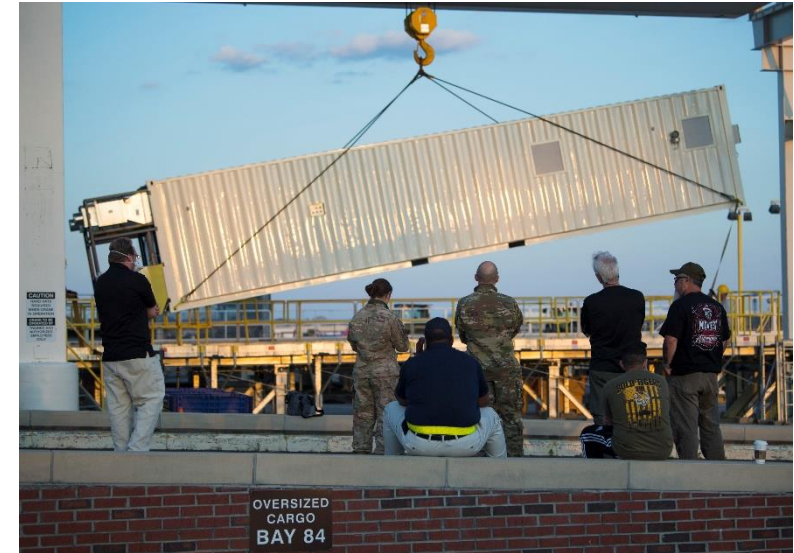


Other Transaction Authority (OTA)



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- Rapid acquisition request for white papers through the CWMD Consortium was released 31 March.
- Source selection met, negotiated, and awarded the bid to UTS Systems, Highland Engineering Inc (HEI) and Delta Flight Products on 7 April.
- The OTA offered flexibility to determine the number of prototype systems for purchase, follow a test-fix-test approach, and modify in accordance with user feedback as units continue to undergo build.





From Prototype(s) to Operational Unit



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Parallel efforts were worked to certify the operational units and acceptance through assessments, analysis and inspections were conducted to meet the rapid program schedule

- **Acceptance through Assessment**

- The 28th Test and Evaluation Squadron assessed critical performance objectives of the systems to include the ability to maintain a negative pressure environment while accounting for bio containment, purge aerosol contamination, and air exchange rates for adequate oxygen concentration
- AFOTEC Det-2 conducted operational utility evaluations (OUE) to evaluate CCATT, AMC/A3V and AMC/SGR teams with the expected users of the systems to validate the design, evaluate potential CONOPS and TTPS, and inform changes requirement for mission

- **Acceptance through Analysis**

- AFLCMC/WNU, C-17 SPO, and C-130 SPO(s) have worked hand in hand with the contractor(s) to ensure structural analysis and appropriate engineering studies have been conducted for risk assessment and mitigation recommendations for safe to fly and airworthiness certification(s).

- **Acceptance Through Inspections**

- The NPC Program Managers, Chief Engineers, and SPO representatives conducted on site oversight during manufacturing, executing system checks and design validation for acceptance of the system as well as upon system delivery. These systems checks and validations continue forward as an acceptance process for all future units



Requirements Objectives



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Acceptance through assessment and analysis resulted in three primary objectives tested and worked to validate the NPC and NPC-L for fielding:

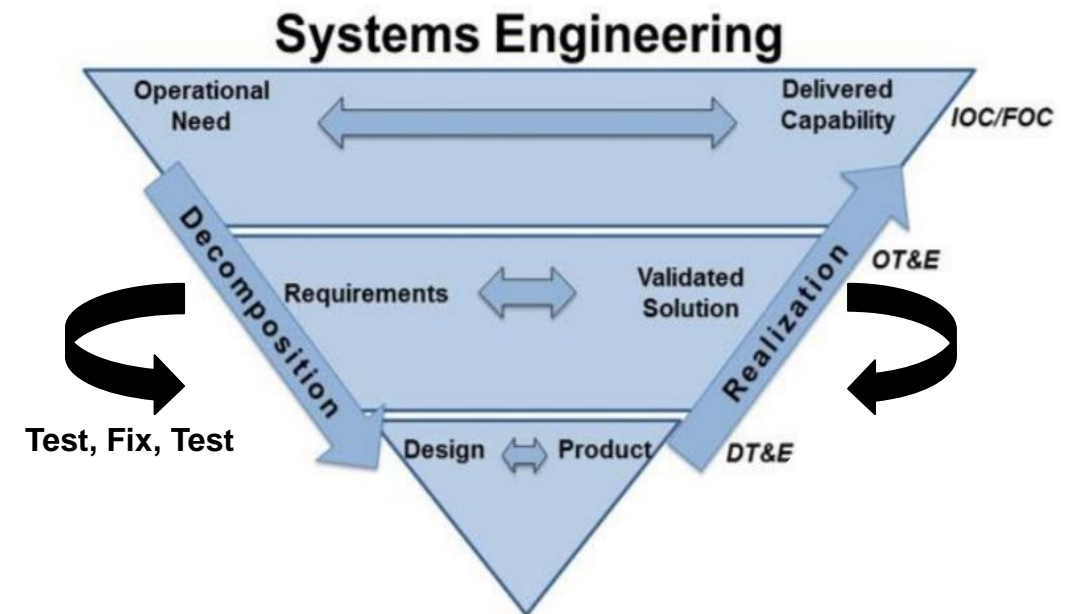
- **Objective 1:** NPC can/will contain bio-contaminants
 - NPC can/will create and maintain a negative pressure environment
 - NPC can/will prevent the passage of particles greater than 0.3 microns at 99.97%
 - NPC can/will provide a minimum of 12 air exchanges per hour
 - NPC: 12 air exchanges per hour with a single blower, 18 with both blowers
 - NPC-L: 23 air exchanges per hour with a single blower, 25 with both blowers
- **Objective 2:** NPC can/will meet the min req'ts for passenger transport
 - NPC can/will be capable of high capacity passenger transport
 - NPC: 30 seats, 5 litter stanchions
 - NPC-L: 17 seats, 2 litter stanchions
 - NPC can/will provide the minimum requirements for aeromedical teams to operate safely
 - NPC can/will provide the minimum requirements for CCATT teams to safety operate
- **Objective 3:** NPC can/will meet Safe to Fly & Airworthiness Requirements
 - NPC can/will meet requirements for ATTLA
 - NPC can/will meet requirements for Safe to Fly (AFLCMC/WNU)
 - NPC can/will meet requirements for Airworthiness Certification (A/C SPOs & AFLCMC/EN)



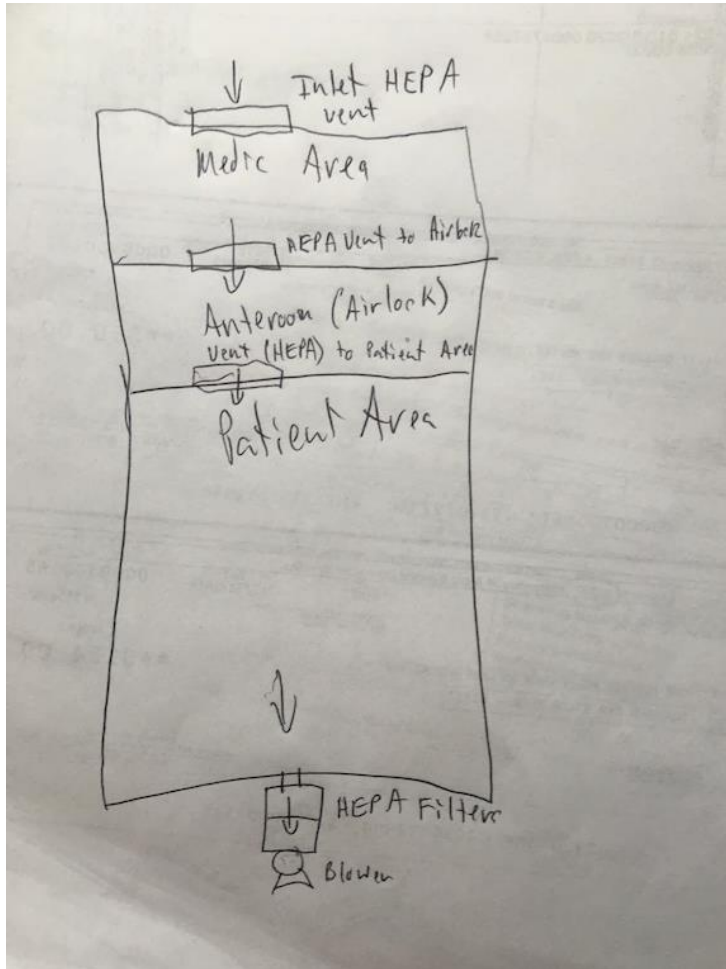
Rapid Engineering

“Test, Fix, Test Approach”

- Testing strategy was developed to accommodate system failures
 - If testing identified a requirement was not being met, manufacturer had opportunity to make adjustment to system, document, and re-test
 - This strategy saved months off of the testing schedule
- System was designed with 3 objectives: biocontainment, airworthiness/safe to fly, and passenger/patient transport



Assumptions The Approach



• What Came of our Assumptions:

- 40 foot shipping containers already certified for use on C-17 aircraft, readily available, and inexpensive
 - Certified only to 3G Crash Loads / not 9G needed for Passengers
 - Aircraft Welding Standards with Steel “different” than used on commercial aircraft
- Production of the NPC would be an integration challenge versus a new development challenge
 - Integration of Military Spec parts isn’t the same as Air Worthiness parts.
- Current C-17 Sidewall seats could be easily integrated into the NPC
 - Current seats are not up to FAA standards. Significant modifications and additions were needed along with testing to meet requirements / attain acceptable risk
- COVID-19 was an urgent threat and speed was prioritized
 - While we did not see the 4000/mo numbers, the system was immediately used (and used often) for over a year. Now the NPC/NPCL have been approved for all High Consequence Infectious Diseases and our design/testing make it a 10yr system for Aeromedical Evacuation Support and Bio-Containment
- We could develop the NPC (and NPCL) to be “Airworthy By Design” – so the actual Airworthiness Process would be smooth
 - We got there, but not without significant give and take and a lot of test-fix-test



Lessons Learned



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Why We Were Successful (What We Had Going For Us):

- The Aeromedical and Test Community were already at Joint-Base Charleston supporting the legacy system testing. We had all the experts in-place ready to develop requirements
- AF CBRN Defense Systems with support of JPEO CBRND was in the right place at the right time with the right team to “jump” on this and go fast (prior innovation)
- We had supportive leadership at C-17, C-130, AFLCMC/EN and all other teams to support the significant impact this had on the workload for their offices
- We had an amazing team of support at AMC/A5, A3, SG and TE
- Joint Base Charleston opened their doors wide open to support
- We had supportive contractors to operate quickly under the OTA and sometimes at risk as the contracting actions and funding caught up w/the program

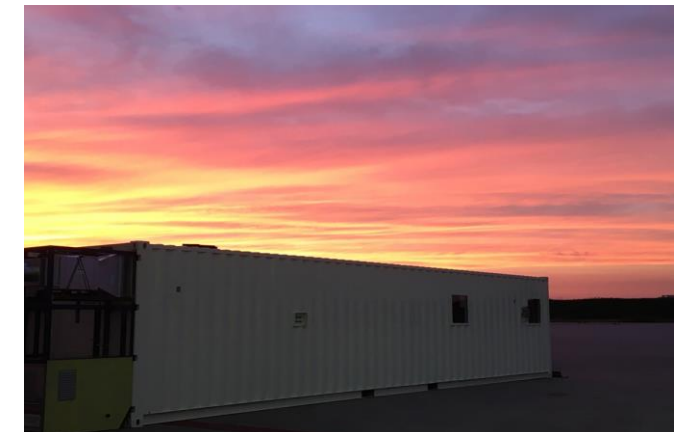


Additional Lessons Learned



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- When the right funding, manning, and experience is focused on an objective the Air Force Acquisition Process can rapidly acquire impactful capability
- Never assume fielded equipment meets today's safety standards
- There is a human cost to acquire a system this rapidly
 - 24/7 Testing Operations
 - 80+ hour weeks for core team for 8 month period
- There is a program cost to other programs
 - Subject Matter Experts that were resourced to support this program could not provide support to their “day job” programs
- You have to complete the circle later on ... bill comes due.
 - All the documentation and formal analysis skipped to meet mission timelines still need to be completed and need resources to do so (if systems are to be kept)
- This entire program was successful because of the Team of Teams we had, the dedication of DoD, Gov't, Contractor, Academia and many more





Questions?



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