

DACOWITS RFI 5

Gender Integration

December 2022



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GENDER INTEGRATION

In 2018, the Committee recommended that, “The Secretary of Defense should require all Military Services, including the Reserve/Guard, provide servicewomen with gender appropriate and properly fitting personal protective equipment (PPE) and gear for both training and operational use.” Though the Military Services have made strides in improving PPE and combat gear for women, the Committee remains interested in the development, procurement, and timelines servicewomen must navigate to obtain gender appropriate and properly fitting PPE, combat gear, and uniforms.

- a. What process is currently being applied to evaluate the effectiveness of PPE and combat gear for women?
 - i. Provide date of last anthropometric study used to develop PPE and combat gear for women.
 - ii. Provide any additional technology/studies utilized to improve PPE and combat gear for women.
- b. What is the current timeline and process to procure equipment via existing supply channels?
- c. What is the current timeline and process to procure alternative equipment (e.g., unique fit) not obtainable via existing supply channels?
- d. Provide an update on modifications to or the development of gender specific PPE, combat gear, and uniforms since June 2018, to include:
 - i. Updates/modifications to maternity uniforms.
 - ii. Updates/modifications to grooming standards.
 - iii. Information related to studies conducted to improve female flight suits.
- e. Provide an onsite visual display that depicts new gender specific PPE and combat gear developed for women



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a. What process is currently being applied to evaluate the effectiveness of PPE and combat gear for women?

NAVSEA manages afloat ballistic PPE for ships and submarines only. Commander, Navy Installations Command (CNIC) manages PPE for ashore security forces and NAVAIR manages aviation PPE. NAVSEA recently conducted (see subparagraph ii below) and plans to conduct future female-focused evaluations for planned body armor systems to identify potential form, fit and function design improvements

To evaluate the effectiveness of PPE and combat gear for women during development, the Naval Air Systems Command's (NAVAIR) design and test planning process derives from the principles in the following guidance documents:

- Joint JSSG 2010-9, Crew Systems: Personal Protective Equipment, Para 3.9.5 Human Engineering, anthropometric sizing, and utilization (Reference 1)
- MIL-STD-1472H, Section 4.5.3 Human Engineering, Section 5.8.4 Anthropometric design, with emphasis on 5.8.4.2.6 Accounting for human variability, (Reference 2)
- AFIC ADV PUB ASM 4084, Methodology for Integration Testing of Aircrew Clothing and Equipment (Reference 3)

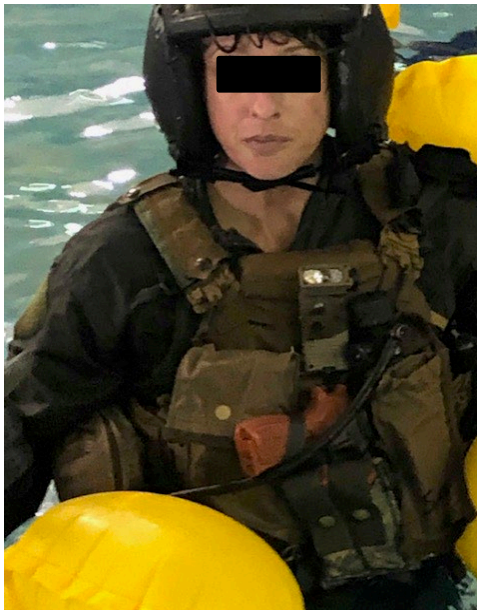
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a. What process is currently being applied to evaluate the effectiveness of PPE and combat gear for women?

NAVAIR's implements the above evaluation procedures using a combination of human subjects, manikins, and computer models:

- Human subjects. For most equipment compatibility, aircraft compatibility, mission mobility, and fit/sizing evaluations, NAVAIR practice is to recruit a wide range of female military human subjects that include at least one subject approximating each JSF Principal Components Analysis (PCA) Cases 1 and 7, which represents the small female (Reference 4). When military subjects are insufficient or unavailable, NAVAIR recruits female civilians.



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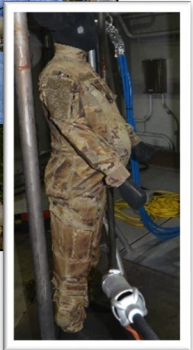
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- Manikins. For life-safety evaluations, such as crash, windblast, ejection, flash-fire, thermal exposure, ballistic testing, and fall arrest, NAVAIR has historically used instrumented manikin protocols in live simulations; when female-representative manikins exist and are available, they are used.

For NAVAIR crash, ejection, and windblast live simulations, small females are represented by the Humanetic's Hybrid III Anthropomorphic Test Dummy JSF Case 1.

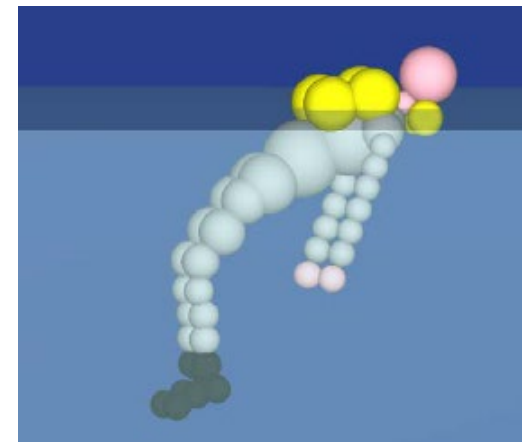
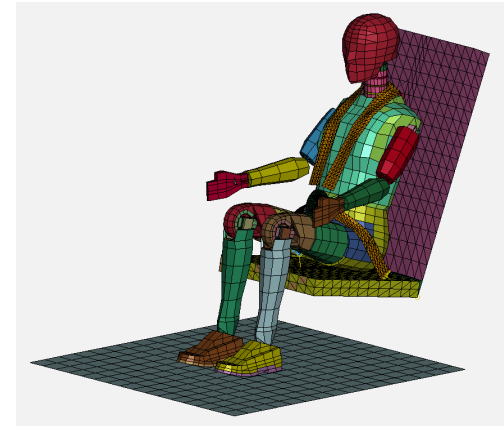
For flash fire simulation, NAVAIR uses the Army Combat Capability Development Center's Thermal Test Facility, and test plans now require the use of their female burn manikin.



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- Computer models. For simulations for which the computer model allows the modeler to specify the size/shape of the human model or avatar, NAVAIR engineers input parameters that simulate the geometry of the Joint Primary Aircraft Training System (JPATS) Anthropometric Cases 1 and 7.
- The Aircrew Protection & Survivability Division has developed in-house LS-Dyna simulations to predict occupant injuries. Using the MADYMO and LS-Dyna databases, which includes mathematical representations of JSF Cases 1 and 7, modelers can simulate the effect of female proportions and gross mass properties on injury probability.
- The Aircrew Protection & Survivability Division has developed a preliminary in-house MADYMO simulation to predict personal flotation behavior in waves. Using the “bubble” feature of the model (a body segment representative of its net buoyancy), modelers can simulate female buoyancy, if those data ever become available for the military population.





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a. What process is currently being applied to evaluate the effectiveness of PPE and combat gear for women?

Female-Specific Neutrally-Buoyant Body Armor. Evaluation of threat defeat is conducted in accordance with the various ballistic protection specifications and procedures for qualification to Level III or Enhanced Small Arms Protective Inserts (E-SAPI) requirements for example. In addition, consideration is placed on assuring that a female-contoured chest armor does not increase the likelihood of a ricochet that would cause damage to unprotected areas. Net buoyancy measurement of the armor is conducted to identify its contributions to the total buoyancy of the occupant-worn equipment.

In-flight Bladder Relief Systems (IBRS). The process being applied to evaluate is through demonstration of the use of the system in a laboratory setting before moving into a demonstration of use in the aircraft. The evaluations are being conducted by aircrew who would be using the system once fielded.

Future design and evaluation tools. USN and USMC aircrew anthropometric data will be used to generate clothing/equipment specific multivariate use cases. These will be similar to the JPATS or F-35 multivariate use cases, but instead of the principal components analysis being based primarily on cockpit accommodation specific anthropometry, they will be generated from clothing and equipment specific measurements. These multivariate use cases will better represent USN/USMC aircrew and can inform computer models and updated physical mannequins or “dress forms”.

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i. Provide date of last anthropometric study used to develop combat gear for women.

The date of the last anthropometric study NAVAIR used to develop combat gear for women was from 1997, for an armored vest program-of-record called Aircrew Endurance. The 2008-2009 developmental phase relied heavily upon the PCA cases of Defining extreme sizes and shapes for body armor and load-bearing systems design (Reference 5) as well as the physical “dress forms” that the Army had fabricated based on that study’s PCA cases to establish general shape, size grades, and adjustability.



Wolf® Dress Forms Representing 1997 Army Extreme Torso PCA Cases used to design the NAVAIR Aircrew Endurance armored survival vest



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i. Provide date of last anthropometric study used to develop PPE and combat gear for women.

The 2012 Army Anthropometric Survey and the 2012 Marine Corps Anthropometric Survey are the most recent direct measured military databases available for development and evaluation of clothing and equipment for general population servicewomen. The 2016 USN Uniform Sizing Correlation Study is a statistically matched database useful for development and evaluation of clothing and equipment for the USN general population. The 2012 US Army Pilot Anthropometric database is available for US Army aircrew clothing and equipment applications, and may be of some use for USN/USMC helicopter pilot as well.

For the development of In-Flight Bladder Relief System, **none of the military anthropometric studies have the data required for the human interfaces** and therefore were not used. The data the developers required are measurements that are gynecological and the medical field in general does not appear to have this information.

Anthropometrically accurate display mannequins, whether male or female, have been challenging to procure. Current HSE mannequins are either sporting equipment retail mannequins or sewing dress forms that are padded out to reflect different anthropometries. PMA 202 is in the process of procuring a range of anthropometrically accurate male and female mannequins to display aircrew systems products (uniforms, PPE, etc.).



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ii. Provide any additional technology/studies utilized to improve PPE and combat gear for women.

The Naval Air Warfare Center Aircraft Division's Body Mounted and Survival Systems branch utilizes literature searches of academic journals as well as Government/Defense studies available through the **DTIC R&E Gateway** that specifically identify physiological and morphological gender differences for ballistic protection, thermoregulation, body and head mounted gear retention. Other tools that NAVAIR utilizes are patent searches, and requests for information or market survey postings in sam.gov prior to each developmental effort.

The Low Cost Bladder Relief SBIR's are not a study but will provide new technology or application of existing technologies in a new use. The systems will provide the capability of bladder relief in-flight without removal of restraint systems. The capability of easy, low cost bladder relief results in aircrew remaining hydrated during flight resulting in maintaining readiness and performance.

Afloat Navy PPE requirements primarily support personnel requiring shipboard ballistic protection. The acquisition strategy for shipboard ballistic PPE is part of an overarching equipment line which accommodates antiterrorism (AT), visit, board, search and seizure (VBSS), and exposed battle station (e.g., crew-served weapons) missions. These shipboard operational requirements are established by the Naval Surface, Air and Submarine Force Commanders and endorsed by Commander, United States Fleet Forces Command. Inherent storage constraints onboard ships and submarines, precludes individual issue of ballistic PPE and has compelled development of highly adjustable solutions to mitigate challenges with establishment of universal tariffs across multiple sizes to accommodate mixed gender crews.



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ii. Provide any additional technology/studies utilized to improve PPE and combat gear for women.

NAVSEA funded a Fit Size Evaluation of the Maritime Armor System (MAS) on Navy Female Personnel in March 2022 after significant delays due to COVID-19 travel and group gathering protocol restrictions. The evaluation was conducted by US Army Combat Capabilities development Command (CCDC) Soldier Effectiveness Directorate Applied Ergonomics Team.

Evaluation included taking sixteen anthropometric measurements for the 43 Test Participants (TPs) with eleven of those TPS participating in a separate Human Factors (HF)/User Evaluation (UE) assessment to evaluate gross mobility and comforts issues.

Evaluation results indicated a need to rapidly introduce a size Small MAS variant. A contract modification and Delivery Order was executed Q4FY22 to support Q2FY23 introduction. Evaluation results and fleet feedback is also being applied to design improvements for the next afloat armor system planned for introduction FY26.

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The Naval Air Warfare Center Aircraft Division (NAWCAD) has also recognized the need for an anthropometric database specific to USN and USMC aircrew. Preparation for the USN & USMC Anthropometric Aircrew Survey effort began in FY22, with data collection to take place in FY23. The database will include the same DOD standardized anthropometry as 2012 Anthropometric Survey (ANSUR) and 2012 Marine Corps Anthropometric Survey (MCANSUR), and several measurements specific to body armor that were not included in ANSUR/MCANSUR will also be collected. Head, hand, body, and foot 3D scans are being collected.



The project is currently seeking funding to add in collection of range of motion data, which has the potential of being useful when evaluating the impact of new PPE and combat gear on range of motion. The sample goal is 3765 personnel, with a project imperative being to collect a sample that will allow appropriate characterization of the population with regard to gender, race/ethnicity, and age. Pregnancy is not exclusionary criteria for the survey, and pregnant women will be encouraged to participate, with a separate report and database if the sample allows.



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b. What is the current timeline and process to procure equipment via existing supply channels?

(Developmental) Abbreviated ACAT: ~7 years from Initial Capability Document to Initial Outfitting
(Non-developmental) Adapting COTS: 2-4 years from approved Fleet request to Open Purchase Authorization

Neutrally-buoyant female-specific armor should be producible and deliverable within two years of qualification. Qualification is dependent on performance and user evaluations, but should be achievable within 2 years depending on supply-chain and backlog issues.

For the IBRS in development, a Phase III SBIR contract that is a Basic Ordering Agreement (BOA) with delivery orders will be put in place. This will enable funding the company for Non-recurring engineering (NRE) costs to move into a production status and ordering systems for Low Rate Initial Production (LRIP) and future production systems. The BOA fills a gap as the new system would transition to Defense Logistics Agency (DLA) for sustainment. It is estimated that the timeline to achieve DLA sustainment is 3 years. For other female size items such as anti-exposure coveralls, women's one piece flight suits, women's long underwear, these are all available through DLA. The timeline from placing an order to receipt appears to be about 3 weeks if DLA has the items on the shelf. The availability is also impacted by DLA policy on the level of stock being maintained. On low demand items, the stock levels on hand have diminished and could take a long time for DLA to procure and provide to fill the order. Availability is also affected by supply chain issues. Based upon conversation with manufacturers, lead times on Flame Resistant (FR) materials is now over 20 weeks.



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b. What is the current timeline and process to procure equipment via existing supply channels?

Afloat body armor is centrally managed by NAVSEA and issued to ships/submarines on a 48-60 month cycle to provide either replacement of the same system or introduction of new body armor systems. Delivery of equipment to the distribution point after delivery order award takes between six and eight months.



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c. What is the current timeline and process to procure alternative equipment (e.g., unique fit) not obtainable via existing supply channels?

Procuring alternate equipment such as a flight suit or glove for a size not covered by standard stock is about 60 days (based upon anecdotal information). This is a question best answered by DLA. DLA does include a custom fit clause on the clothing contracts to expedite the process and to maintain the same cost as the stocked item.

With the exception of modified sizing tariffs for unique crew compositions, alternative systems are not available for procurement for issue to ships. Body armor is issued per established tariffs in an optimal quantity to meet concurrent mission requirements. Due to storage constraints, allowance quantities are significantly less than crew size, compelling communal use of available systems.



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d. Provide an update on modifications to or the development of gender specific PPE, combat gear, and uniforms since June 2018, to include:

i. Updates/modifications to maternity uniforms.

NAVAIR is planning on being a user of the maternity flight suits being developed by the Air Force. As an interim measure to accommodate pregnant aircrew, existing flight suits are being modified for the aircrew until the permanent solution is available through DLA. PMA202 is funding the modification. Pregnant aircrew have been authorized to obtain 2 additional flight suits for this process. The flight suits are purchase by the command to which the aircrew is assigned.

- Nursing T-shirts are authorized for wear with all uniforms for nursing Sailors.
- Improved Summer White/Service Dress White maternity top/shirt designed incorporates a more modern streamline appearance by adding adjustable side tabs, removing breast pockets and adding princess seams to the front and back of the shirt.
- Design improvement of the maternity Service Dress Blue coat to include side adjustment throughout the term of pregnancy is planned for future introduction. Other design features being considered to modernize appearance.
- Modification of the Navy Working Uniform Type III (NWU Type III) maternity shirt to facilitate optional wear of shoulder patches to align with the standard NWU Type III shirt, is in progress.



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d. Provide an update on modifications to or the development of gender specific PPE, combat gear, and uniforms since June 2018, to include:

ii. Updates/modifications to grooming standards.

Navy's female hair grooming standards since 2018 have been expanded as a result of fleet feedback, diversity, equity and inclusions (DEI) efforts, and leadership direction to include the following:

- Single braid, French braid, or a single ponytail in Service, Working, and PT uniforms.
- Ponytails may extend up to three inches below the lower edge of the collar unless determined to be a safety hazard (commanding officer determination).
- Width or diameter of the hair bun may be equal to width of the back of the head.
- Locks may be worn in short, medium, and long hair lengths. Locks may also be loose (free-hanging where no hair is added to the lock once it is started other than hair extensions that are attached at the end of the natural hair).
- Locks may be spaced up to three-eighths of an inch apart, and diameter/width up to three-eighths of an inch wide.
- Locks may also be worn in a bun provided all hair grooming requirements are met.
- Hair may be worn below the lower edge of the collar of the blouse, jacket, or coat when wearing the Dinner Dress uniform.
- Short length hairstyles showing scalp, having a hard part or tapered back and sides is authorized.
- Medical head coverings may be worn in uniform for Sailors undergoing prescribe medical care that results in a loss of hair or scalp too sensitive to wear a cover or hair piece.



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The Navy has also expanded other areas of female grooming standards aligned with fleet feedback, DEI initiatives and recruitment and retention efforts. The most noteworthy policy changes since 2018, includes the following:

- Implemented jumper style Service Dress Blue uniform with side jumper zipper and front zipper slacks commensurate with iconic Navy uniform image.
- Implemented new design Service Dress White jumper top to include cuffed sleeves with piping and jumper flap with piping.
- Authorized wear of Flats (footwear) with Service and Service Dress uniforms.
- Increased authorized dress shoe heel height to accommodate ease of availability and purchase on the commercial market.
- Aligned utilization of belted slack with both Summer White and Service Dress White uniforms to align with male officers/CPO uniform wear requirements and reducing out-of-pocket expenses. Redesignated unbelted slacks as optional vice mandatory.
- Authorized optional wear of hosiery with all uniforms. Shoe liners/foot socks required if hosiery is not worn.
- Corrected dual and single identification badge (ID badge) manner of wear to facilitate equal visibility on female uniforms commensurate that of ID badge visibility on male uniforms.
- Authorized optional full body and 2 piece swim wear authorized as to include burqinis/burkinis, board shorts, square shorts, Navy physical training uniform shirt with rash guard top.



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The Navy has also expanded other areas of female grooming standards aligned with fleet feedback, DEI initiatives and recruitment and retention efforts. The most noteworthy policy changes since 2018, includes the following:

- Authorized fingernail shapes to include round, almond/oval, or square. Additionally, French and American manicures (white and off-white tips with neutral base color ONLY) are authorized.
- Authorized bracelet and ring materials and colors worn in uniform to include natural metals or fabricated materials (i.e., plastic, wood, silicone, etc), in colors of gold, silver, copper, grey, tan, brown, black, white or light pink in color.
- Unauthorized nail polish colors specified to include white, black, red, yellow, orange, green, purple, blue, hot pink, grey, glitter, striped, or any sort of pattern/decorative nails.
- Sailors assigned to U.S. Marine Corps units who wear the Marine Corps uniform will abide by Marine Corps grooming standards

iii. Information related to studies conducted to improve female flight suits

NAVAIR will also be submitting a technical data package for a Navy version of the 2 piece flight suits which will include female specific sizing. The male/unisex sizing was developed by the Army and the female sizing was developed by the Air Force. The Navy is making modifications to the patterns for pocket design and will require the items be produced in sage green instead of the Operational Camouflage Print (OCP) worn by the Army and Air Force.

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Neutrally-buoyant female-specific body armor. For the neutrally-buoyant female-specific body armor, shaping is being conducted to result in two specific female-shaped chest armor plates as proposed prototypes. These will be considered in early anecdotal evaluations that will inform the questions/measurements that are required in future anthropometric studies that will be defined for proper fitment of armor and other PPE devices. Radius of armor curvature, center of curvature, and inflection of complex curvature segments are some of the adjustable parameter that are presently being investigated. Other constraints are the ability to tool ceramic manufacturing processes to accommodate complex plate curvatures and the presentation of the armor to the incoming round to prevent ricochet issues. This effort is ongoing to look at a development project that can result in a viable PPE product for females and inform future studies.

Female Body Armor - Point of Tangency (POT)

Profile Comparison



Point of Tangency (POT): The point of tangency has been “lowered” by 3” causing the largest possible increase in lateral curvature possible with this parameter.

POT-3”



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Honeywell Biosensing Apparel (HBA) - PMA-202 is working collaboratively with multiple contractors through the Defense Innovation Unit (DIU) to develop passive physiological monitoring prototypes. The Honeywell Biosensing Apparel (HBA) comes in a shirt or sports bra form factor and features an electrocardiogram (ECG), respiration monitor, and motion detector. The apparel includes two main components: the sensing garment and the recording module. Both garment and module fit under aircrew's flight suit and are intended for wear during both flight operation and outside activities.

