



The EMU vs. The Astronaut



EIS Then and Now Tracking the Human-Suit Interface

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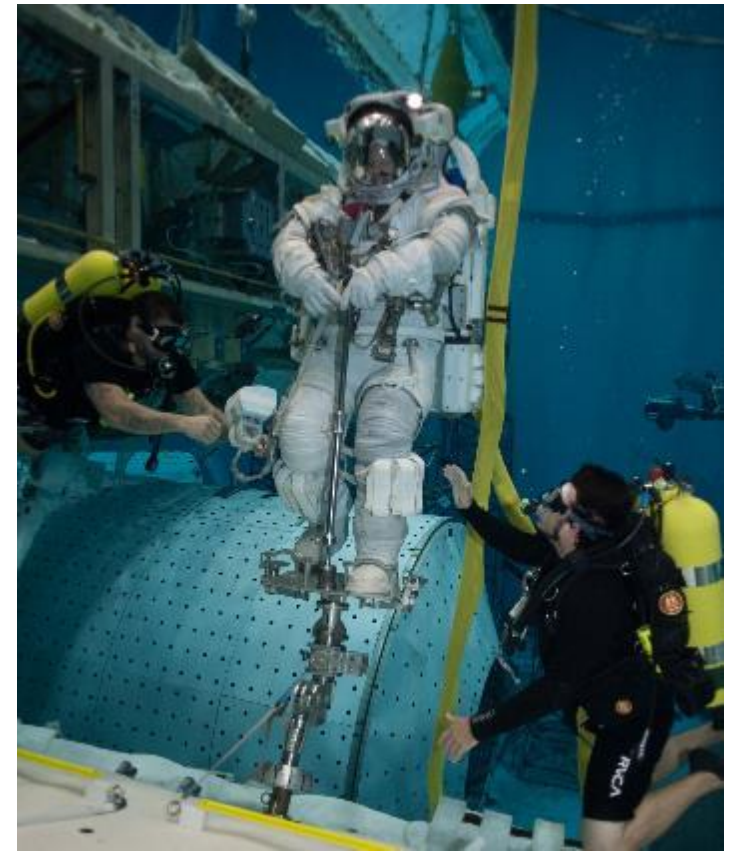
Assistant Professor

University of Texas Medical Branch, Galveston



The Problem

- Over the years we have identified several significant injuries
 - Shoulder injuries (Slap, rotator cuff)
 - Knee injuries (meniscal tears)
 - Fingernail Delamination
 - What else?





Document to Prevent



- EIS

dev-mmis.ndc.nasa.gov

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APPLICATION IN SYSTEM TESTING

Exercise Injury System

Welcome NDCInwanda11

Home Admin ASCR NBL Doctor

NBL Home Exposures Dive Profiles Conditions Divers Manage Selection Lists

Create NBL Exposure

Diver
 Include Inactive

Event Date
 [clear](#)

Exposure Duration (hh:mm)
 [clear](#)

Comments
 [Characters: 3](#)

Total Inverted Time (hh:mm)
 [clear](#)

Hut Type
 Pivoted Planar

Wrist Bearing Type
 Aluminum Steel

Shoulder Harness Used
 True False

Shoulder Pads Used
 True False

Used Teflon Inserts
 True False

Locations Iced
 Right Shoulder
 Left Shoulder
 Deferred

[Create](#)

[Back to List](#)

[Leave Feedback](#)



Sometimes We Fail





EIS



- We have learned a lot
 - Shoulder injury prevention
 - ASCR Conditioning
 - Inverted Ops
 - Minimize repeated failed attempts

- But learned from injury
- Attributed to the suit



EIS 2.0



- Desire to learn more about the “pre-exposure” subject (vs. suit)
 - Prone to injury?
 - Sleep?
 - Hydration?
 - Activity level and type
 - Are they ready/fit?
 - Preexisting injury?

The screenshot displays the 'Exposure Incident System 4.0' web interface. The main content area is titled 'Dive Exposure - Astronaut X'. It features a navigation bar with tabs for 'Pre-Built Exposure', 'Pre-Built Diving', 'During Built Exposure', 'Post-Built Exposure', 'Follow Up', 'Issues', and 'Conditions'. Below the navigation bar, there are two buttons: 'Edit Pre-Built Exposure' (green) and 'Back to List' (orange). The form contains the following fields:

- Date and Time (MM/DD/YYYY HH:MM):** 7/15/2024 10:07
- Subject:** Astronaut - Unassigned
- Mission:**
- Exposure Type:** NSL EVA Training
- Location Of Exposure:** NSL
- NSL Run Title:** CB EVA Probe Test, 301C SPDM LUB604
- TD, FS, Tank Content Percent:** Horizontal
- Suit Type:** EMU - Mars
- Suit Engineer:** Roger Chalmers
- HUT Mile:** 1/0
- OFF-Nominal:** Not Arrived
- Shoulder Protection Used:** Not Arrived
- Glove Used:** Phase V
- Waist Bearing Used:** Arrived
- LTA Used:** EMU LTA
- Boot Used:** EMU Boot
- Pressure Used:** 40-43 PSI

At the bottom of the form, there are two buttons: 'Edit Pre-Built Exposure' (green) and 'Back to List' (orange).



EIS 2.0



Browser window: mmis.ndc.nasa.gov

Create Sanders, Robert W. USO-SD3|WYLE LABORATORIES... Details 401 - Unauthorized. Access is denied due to invalid...

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Welcome NDCrwsander! [Leave Feedback](#)

Exposure Incident System 4.0 Home NSL Doctor

NSL Home **NSL Exposures** Historical Dive Profiles Conditions Reports Manage Incident Lists

Dive Exposure - Astronaut X

Pre-Suited Exposure Pre-Suit Donning During Suited Exposure Post Suited Exposure Follow Up Issues [Go to Home](#)

[Edit Pre-Suited Exposure](#) [Back to List](#)

Date and Time (MM/DD/YYYY hh:mm):
7/15/2024 15:07

Subject:
Astronaut - Unassigned

Mission:

Exposure Type:
NSL EVA Training

Location Of Exposure:
NSL

NSL Run Time:
CB EVA Holes Flex (BPC SPOM LUBE4)

TD, PI, Task Contact Person:
Frankie

Suit Type:
EMJ - Planar

Suit Engineer:
Roger Graham

HUT Size:
Med

OFF-Nominal:
Not Answered

Shoulder Protection Used:
Harness

Glove Used:
Phase V

Wrist Bearing Used:
Aluminum

LTA Used:
EMJ LTA

Boot Used:
EMJ Boot

Pressure Used:
4.0-4.3 FEI

[Edit Pre-Suited Exposure](#) [Back to List](#)



EIS 2.0



Browser tabs: mms.ndc.nasa.gov

Navigation: Home, NBL, Doctor

Buttons: NBL Home, NBL Exposure, Historical Dive Profiles, Conditions, Rates

Dive Exposure - Astronaut X

Pre-Suited Exposure | Pre-Suit Donning | **During Suited Exposure**

[Edit Pre-Suited Exposure](#) [Back to List](#)

Date and Time (MM/DD/YYYY hh:mm):
7/15/2024 15:07

Subject:
Astronaut - UnAssigned

Mission:

Exposure Type:
NBL EVA Training

Location Of Exposure:
NBL

NBL Run Time:
CB EVA Home Rev (BPC SPOM LUBE4)

TD, PI, Task Contact Person:
Frankie

Suit Type:
EMJ - Planar

Suit Engineer:
Roger Graham

HUT Size:
Med

OFF-Nominal:
Not Answered

Shoulder Protection Used:
Harness

Gloves Used:
Phase V

Wrist Bearing Used:
Aluminum

LTA Used:
EMJ LTA

Boot Used:
EMJ Boot

Pressures Used:
4.0-4.3 PSI

[Edit Pre-Suited Exposure](#) [Back to List](#)

Dive Exposure - Astronaut X

Pre-Suited Exposure | Pre-Suit Donning | **During Suited Exposure**

[Edit Pre-Suit Donning](#) [Back to List](#)

Are you hydrated?
Yes

Are you fed?
Yes

Can you clear your ears?
Yes

Are your sinuses clear?
Yes

Did you get sufficient sleep last night?
Yes

Total hours of sleep (hours):
7.5

Do you have any pain, discomfort, or injuries to report prior to donning?
No

Do you participate in any leisure time or ASCR prescribed physical activity?
Not Answered

Exercises

Type	#
Cycling	1
Functional Fitness	1
Running/Jogging	1
Swimming	1

Other Activities:

Pre-exposure intervention therapies used:

- Non-Prescription Medication (e.g. Ibuprofen)
- NBL Hardener

Other pre-exposure intervention therapies:

Indicate all other countermeasures (e.g., padding, moleskin, etc.):

Change in countermeasures was only for this suit exposure:
Not Answered

[Edit Pre-Suit Donning](#) [Back to List](#)

Dive Exposure - Astronaut X

Pre-Suited Exposure | Pre-Suit Donning | During Suited Exposure | **Post Suited Exposure** | Follow Up | Issues | Conditions

[Edit Post-Suit Exposure](#) [Back to List](#)

Total Time Suited (hh:mm):
05:45

Number of times HUT donned:
1

Total Unplanned doffing events:
0

For all Don events:

Left Lower Arm: Attached Right Lower Arm: Attached

For all Doff events:

Left Lower Arm: Attached Right Lower Arm: Attached

Total Time Pressurized (hh:mm):
05:45

Total Time Inverted (hh:mm):
00:00

Do you have any pain, discomfort, or injuries to report?
Yes

Post-exposure therapies administered:

- Declined

Lead Locations:

- Deferred

Other post-exposure therapies:

Are additional countermeasures recommended to be added or removed for subsequent suited events?
Not Answered

Additional Comments

[Edit Post-Suit Exposure](#) [Back to List](#)

[Audit History](#)



EIS 2.0



Four browser windows showing the EIS 2.0 interface. The main window displays a form for 'Dive Exposure - Astronaut X' with various tabs and sections.

Navigation: Home, NBL, Doctor, NBL Exposure, Historical Dive Profiles, Conditions, Subject, Manage Selection Lists

Form Sections:

- Pre-Suited Exposure:** Edit Pre-Suited Exposure, Back to List
- Pre-Suit Donning:** Edit Pre-Suit Donning, Back to List
- During Suited Exposure:** Edit Post-Suit Exposure, Back to List
- Post-Suit Exposure:** Edit Issues, Back to List

Form Fields:

- Date and Time (MM/DD/YYYY hh:mm): 7/15/2024 15:07
- Subject: Astronaut - UnAssigned
- Mission:
- Exposure Type: NBL EVA Training
- Location Of Exposure: NBL
- NBL Run Time: CB EVA Home Rev (BPC SPOM LUBE#4)
- TD, PI, Task Contact Person: Frankoc
- Suit Type: EMU - Planar
- Suit Engineer: Roger Graham
- HUT Size: Med
- OFF-Nominal: Not Answered
- Shoulder Protection Used: Harness
- Glove Used: Phase V
- Wrist Bearing Used: Aluminum
- LTA Used: EMU LTA
- Boot Used: EMU Boot
- Pressures Used: 4.0-4.3 FEI

Questions and Answers:

- Are you hydrated? Yes
- Are you fed? Yes
- Can you clear your ears? Yes
- Are your sinuses clear? Yes
- Did you get sufficient sleep last night? Yes
- Total hours of sleep (hours): 7.5
- Do you have any pain, discomfort, or injuries to report prior to donning? No
- Do you participate in any leisure time or ASCR prescribed physical activity? Not Answered

Exercises:

Type	Count
Cycling	1
Functional Fitness	1
Running/Jogging	1
Swimming	1

Other Activities:

- Pre-exposure intervention therapies used:
 - Non-Prescription Medication (e.g. Expirant)
 - NBL Hardener
- Other pre-exposure intervention therapies:

Additional Comments:

Indicate all other countermeasures (e.g., padding, mo'ni skin, etc.):

Change in countermeasures was only for this suit exposure: Not Answered

Table:

Body Location	Time Frame	Pain Scale	Symptoms	Signs	Local Location	Comments
Left Hand - Finger(s)	During	1	• None	• None	No	Small fingers shaking post-run. "gloves too big - they splay my fingers too much."
Right Hand - Finger(s)	During	1	• None	• None	No	Small fingers shaking post-run. "gloves too big - they splay my fingers too much."

Audit History:



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Create Sanders, Robert W. (J5C-5D3)[WYL... NBL Home 401 - Unauthorized: Access is de...

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Exposure Incident System 4.0 Home NBL Doctor Welcome NDC@rsander1! [Leave Feedback](#)

[NBL Home](#) [NBL Exposures](#) [Historical Dive Profiles](#) [Conditions](#) [Subjects](#) [Manage Selection Lists](#)



Exposure Incident System 4.0 Home NBL

[NBL Home](#) [NBL Exposures](#) [Historical Dive Profiles](#)

Dive Exposure - Astronaut X

Pre-Suited Exposure Pre-Suit Donning Quit

[Edit Pre-Suited Exposure](#) [Back to List](#)

Date and Time (MM/DD/YYYY hh:mm): 7/15/2024 15:07

Subject: Astronaut - Unassigned

Mission:

Exposure Type: NBL EVA Training

Location Of Exposure: NBL

NBL Run Title: CB EVA Home Rev (BPC SPOM LUBE4)

TD, PI, Task Contact Person: Frankrick

Suit Type: EMU - Planar

Suit Engineer: Roger Graham

HUT Size: Med

OFF-Nominal: Not Answered

Shoulder Protection Used: Harness

Gloves Used: Phase V

Wrist Bearing Used: Aluminum

LTA Used: EMU LTA

Boot Used: EMU Boot

Pressures Used: 4.0-4.3 PSI

[Edit Pre-Suited Exposure](#) [Back to List](#)

Dive Exposure - Astronaut X

Pre-Suited Exposure Pre-

[Edit Pre-Suit Donning](#)

Are you hydrated? Yes

Are you fed? Yes

Can you clear your ears? Yes

Are your sinuses clear? Yes

Did you get sufficient sleep last? Yes

Total hours of sleep (hours): 7.5

Do you have any pain, discomfort? No

Do you participate in any leisure? Not Answered

Exercises

Type

Cycling

Functional Fitness

Running/Jogging

Swimming

Other Activities:

Pre-exposure intervention ther

- Non-Prescription Medication
- NBL Hardener

Other pre-exposure interventions

Indicate all other countermeasures

Change in countermeasures? Not Answered

[Edit Pre-Suit Donning](#)

Common Activities

[Create Dive Exposure](#) [Create 1G Exposure](#)

Recent NBL Exposures

	Full Name	Exposure Date	Event Description	Lab	Location of Exposure	Suit Used	LTA Used	Conditions	Actions
Details			1G - NBLWet	NBL EVA/ISS Procedure Development	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA/ISS Procedure Development	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G -	Mission Training		EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	EMU - Planar	EMU LTA	0	Add Condition
Details			1G - NBLWet	NBL EVA Training	NBL	Z-2	EMU LTA	0	Add Condition

Latest NBL Exposures Resulting in a Condition Report

	Subject	Date	Event Description	Condition
Exposure Condition			1G - NBLWet	Bilateral thumb pain 2/2 glove fit issues and "break points" got to point where GM preferred to truncate run, and requested pain med
Exposure Condition			1G - NBLWet	Subconjunctival Hematoma noted after run possibly due to inverted time
Exposure Condition			1G - NBLWet	after the run, the patient complains of pain over her left shoulder, especially in the deltoid region. Patient states throughout the run. She felt

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Welcome NDC@rsander1!

[Leave Feedback](#)

Recent Lists

[Dive Exposure](#) [Follow Up](#) [Issues](#) [Conditions](#)

Signs	Local Location	Comments
• None	No	Small fingers shaking post-run. "gloves too big - they splay my fingers too much."
• None	No	Small fingers shaking post-run. "gloves too big - they splay my fingers too much."



Still just learning from mistakes...

- Modelling can *prevent* the need to learn from “mistakes”
 - Proactive
 - Prevent or Decrease injuries
 - New Suit Design – Injury *prevention*
 - No Need to expose personnel to suit to learn



Modelling is a Solid Answer

- What we know is from EMU in NBL
 - vetted in microgravity.
 -
- No new injury patterns "discovered" in space,
 - our process is "working"
- Imagine the benefit to modeling the suit-human interface...
 - to guide suit use and astronaut training in preventive measures without ever having to injure a crew member
 - For planetary missions, there is no equivalent analog... modeling is our only option



Thank You!

- *There is no perfect suit... There is no perfect human, but with the proper modeling, we may create the ideal human-suit interface ... with virtually all injuries made a thing of the past!*

- Questions?

