Saturation Diving

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ULL, Univ 100-002, April 2023

Saturation Diving

- I chose to do saturation diving because I am a certified commercial diver since March 2022.
- The part of commercial diving I have not gotten into is saturation diving, so I wanted to dive a little deeper into that.

Explanatory Case Study of Saturation Diving

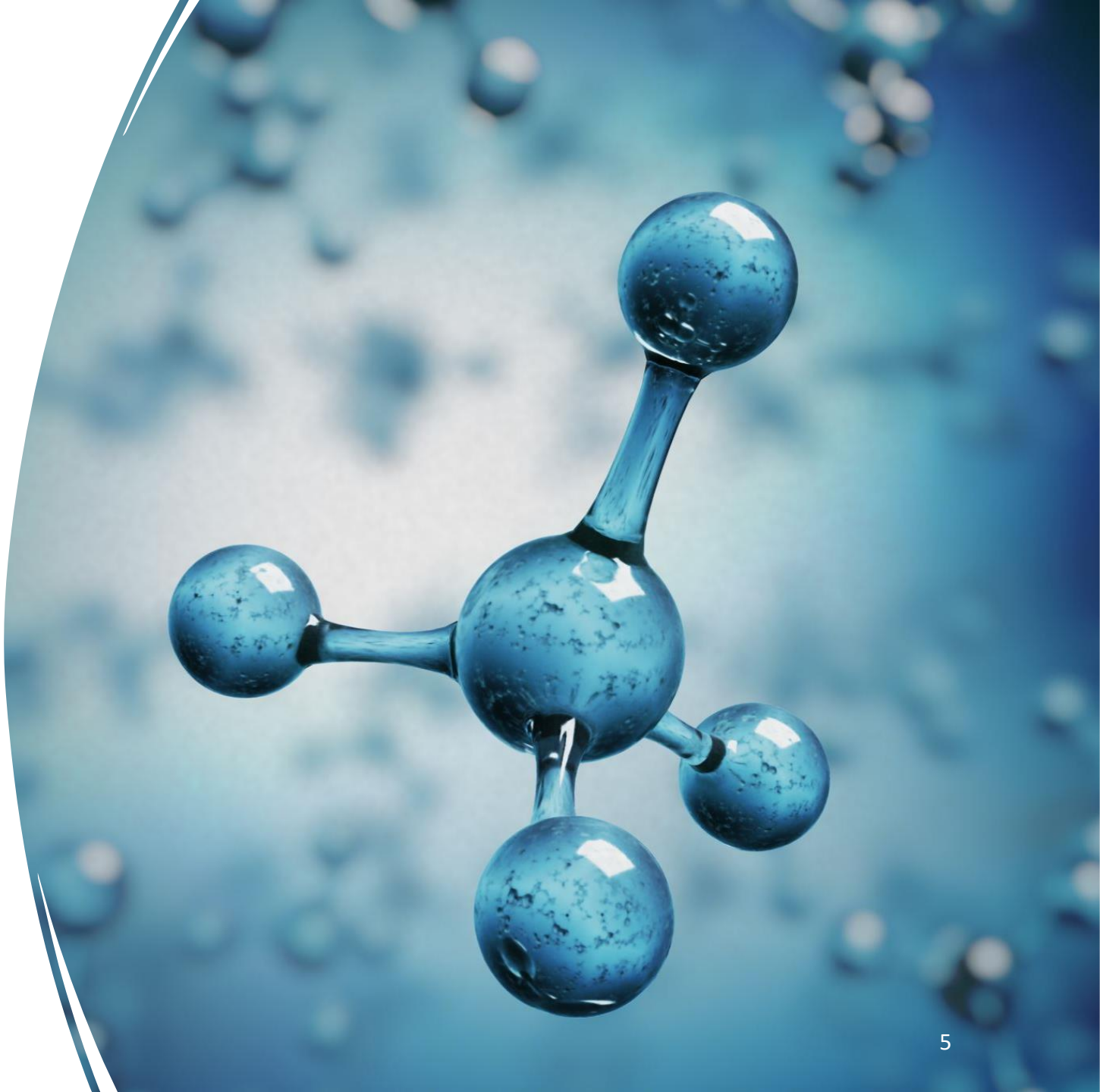
- In this power-point I will be explaining to you why saturation diving is no longer dangerous

Research

- Saturation diving can be dangerous. And has a history of being dangerous. But with modern science and medicine it's is a lot safer.
- **Research question**: Is saturation diving dangerous?
- **Hypothesis**: Saturation diving is not dangerous if you follow protocols.

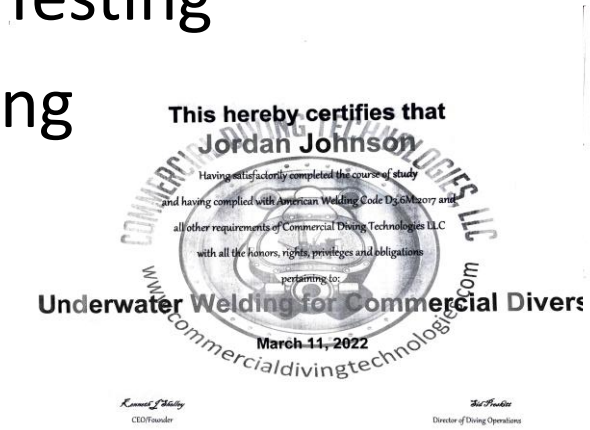
Terms/Terminology

- PPO2 (Partial pressures of Oxygen)
- PPN (Partial Pressures of Nitrogen)
- Narked (Nitrogen Narcosis)
- AT (Atmosphere) every 33ft of seawater and 34 feet of fresh water
- ATA (Atmospheric absolute)
- Umbilical (Dive hose)
- FSW (feet of seawater)
- FFW (feet of fresh water)



Certifications, March 2022
From CDT (Commercial Diving Technologies) Hudson, FL

- DCBC (Divers Certification Board of Canada)
- ADCI
- First Aid, CPR, A.E.D. & O2 provider
- Underwater welder
- Water survival/ HUET
- NDT Testing
- Rigging



Dive School Competencies

DCBC Unrestricted No max depth
ADCI restricted to 100’
Surface Supplied
Open water SCUBA Cert
Saturation School (company dependent)
Underwater burning
Underwater welding
Tool competencies
First Aid, CPR, A.E.D. & O2 provider

Required Diving Equipment

- Dive helmet
- Dive harness
- Bailout (air tank)
- Dive boots
- Wet suit
- Hot water suit (depending on depth and temperature)
- 2 dive knives

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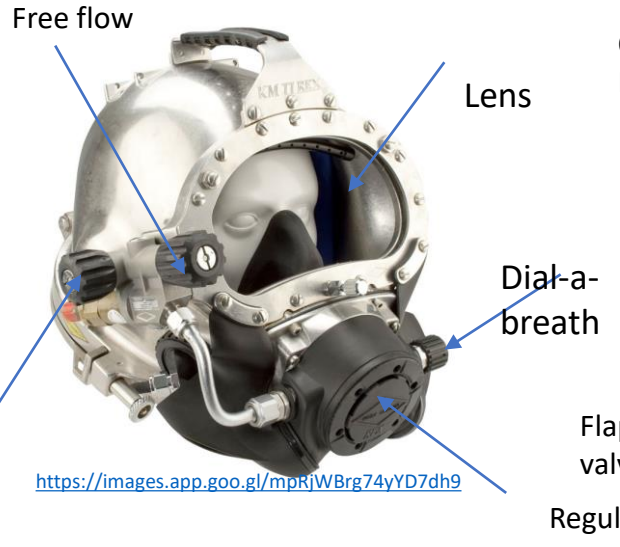
Diving Helmets

- Kirby Morgan
  - Dive helmets
  - Band masks

- Pieces of the dive helmet (outside)
  - Free flow
  - Bent tube
  - Regulator
  - Neck dam
  - Lens
  - Dial-a-breath
  - Bailout



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- Dive helmet (inside)
  - Oral nasal
  - Flapper valve
  - Comms microphone
  - Comms speakers
  - Snoopy (padding)
  - NCD (nose clearing device)

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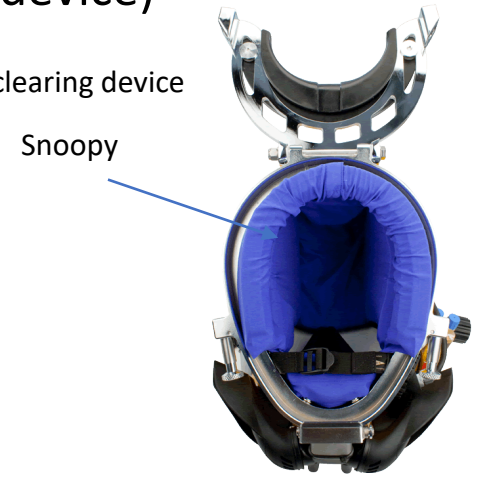

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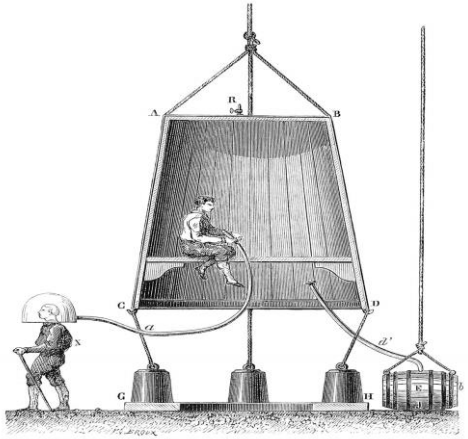
History of Underwater Diving

- Started as free diving to gather food and collectables
- 16002 first documented diving dress
- 1616 open bottom diving bells
- 1942 Jacque Yves-Cousteau co-invents modern regulator (Aqualung is born)



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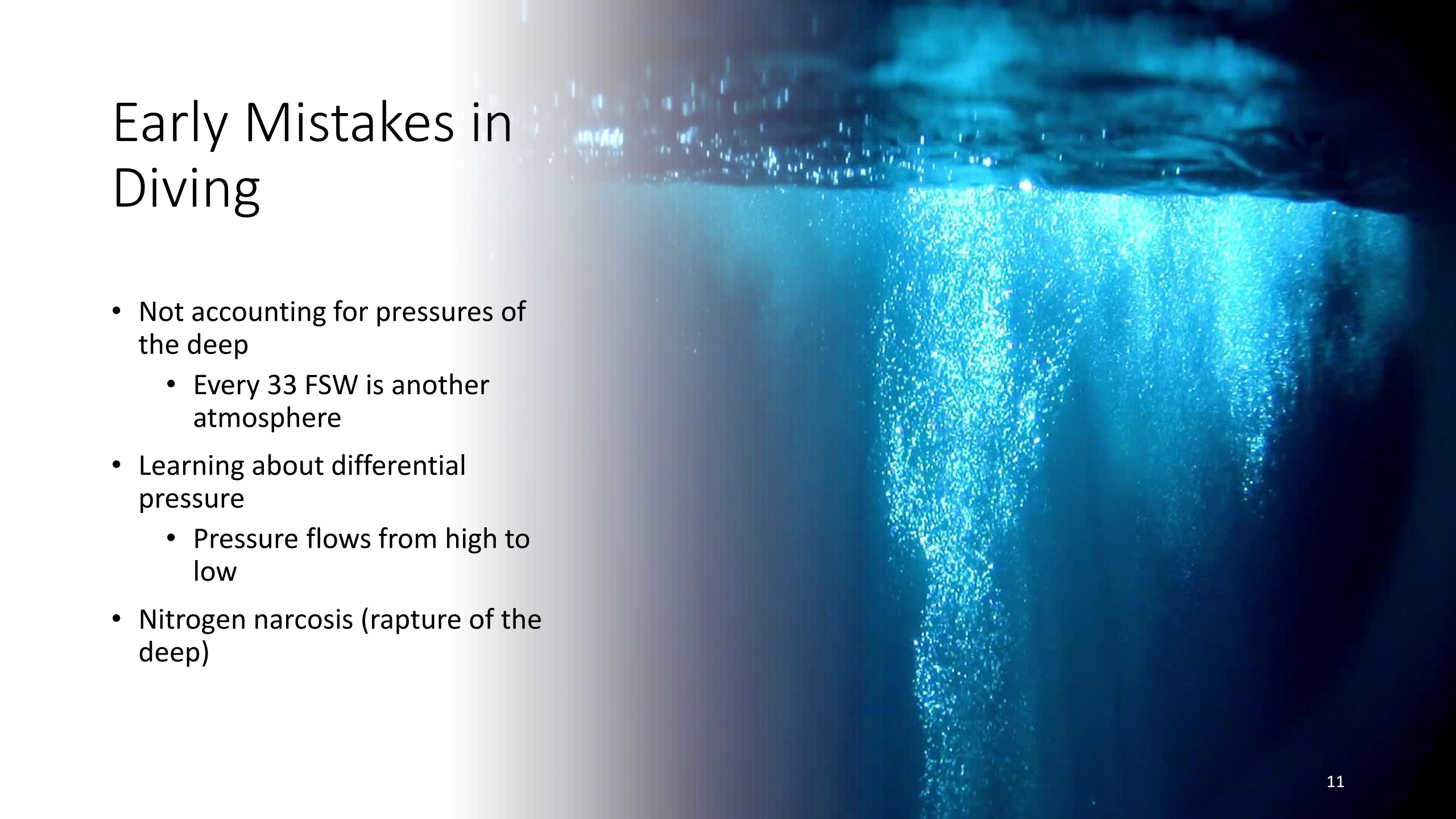
https://images.app.goo.gl/m8GXyFPB23DwE79g6

WEB: Saturation diving. (2023, March 20). In *Wikipedia*. https://en.wikipedia.org/wiki/Saturation_diving

Early Mistakes in Diving

- Not accounting for pressures of the deep
  - Every 33 FSW is another atmosphere
- Learning about differential pressure
  - Pressure flows from high to low
- Nitrogen narcosis (rapture of the deep)



Nitrogen Narcosis (Rapture of The Deep)

- Happens when PPN gets too high
- Usually begins between 100-125 feet
- Hallucinations
- Inability to think clearly
- Euphoric
- Drunk/High feeling

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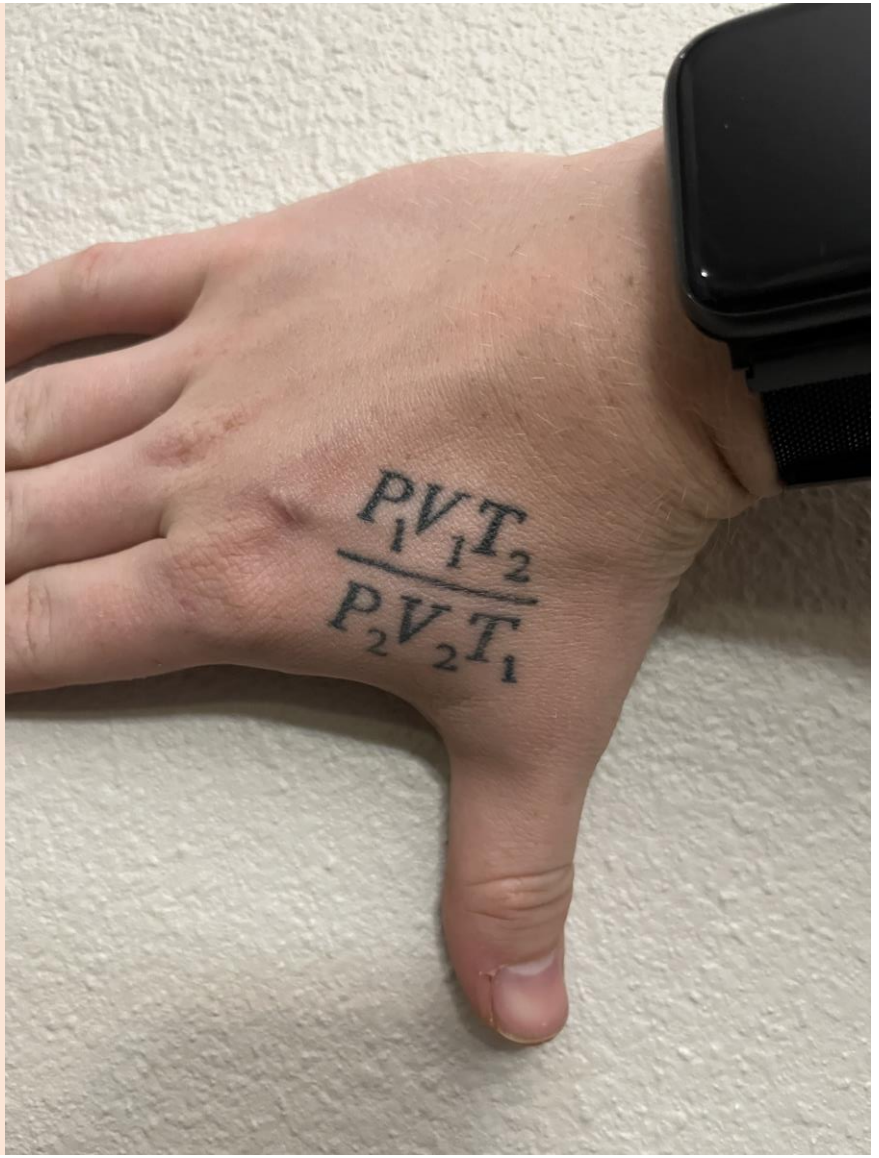
Dive Physics

- Charles Law- As temperature increases volume increases
- Gay-Lussac Law- As pressure increases temperature increases
- Boyles Law- As pressure decreases volume increases
- P= Pressure
- V= Volume
- T= Temperature
  - P1V1T2/P2V2T1= General Gas Law
  - P1V1/P2V2= Boyles' Law
  - P1T2/P2T1= Gay-Loussac' Law
  - V1T2/V2T1= Charles Law



Hyperbaric/Dive Physiology

Due to the partial pressures of O2 you need less O2 as you descend
Max of 50 feet on 100% O2
Possible O2 hit on too much O2
Causes blurred vision, convulsions, irritability and possible death of not corrected
Increased Nitrogen levels (PPN) as you descend (can cause Nitrogen Narcosis)
Have to build a tolerance for Nitrogen Narcosis

Diving Support Vessels (DSV's)

- Supports diving operations to include Saturation
  - Moon pool
  - Dive hoses
  - Four point
  - DPS (Dynamic Positioning System)

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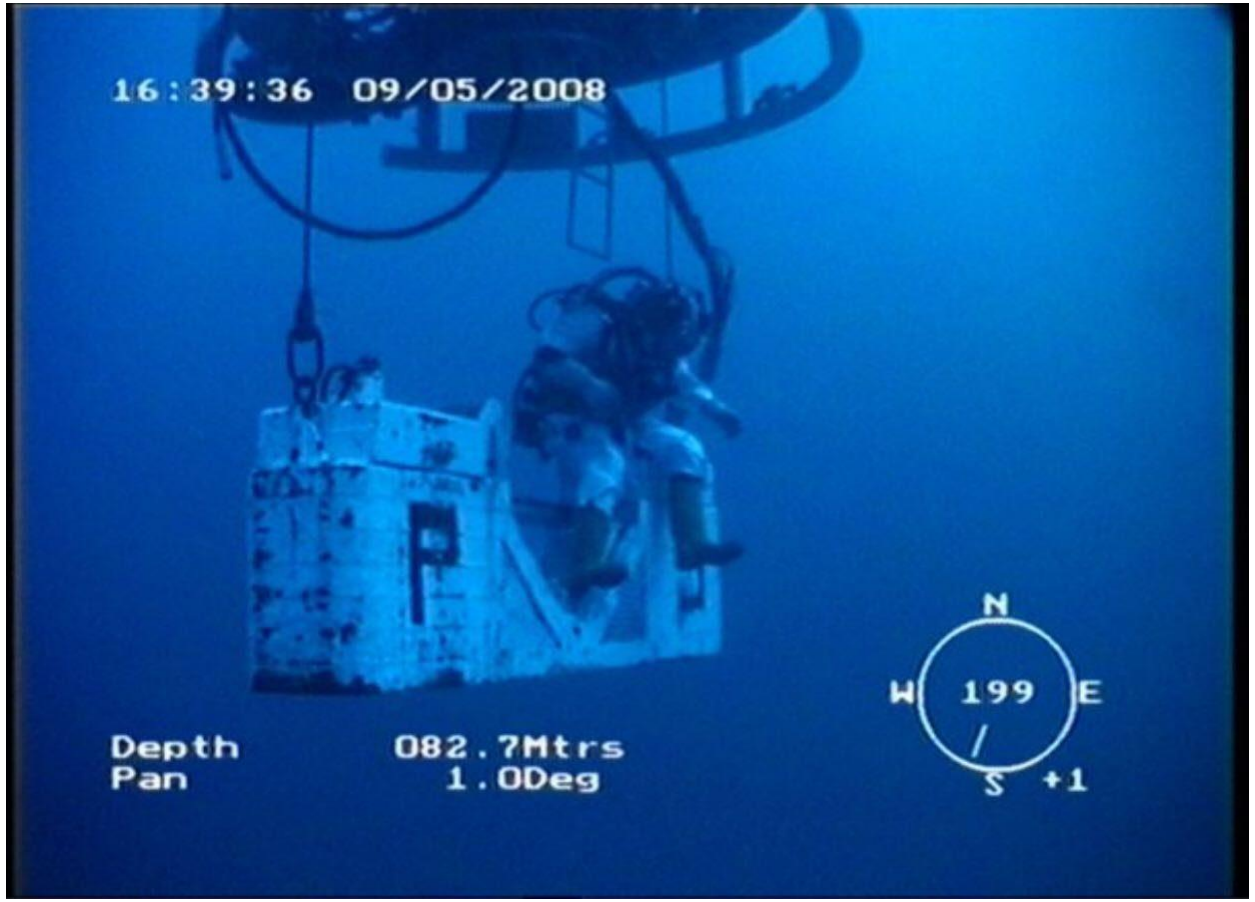
Daily Energy Expenditure of Saturation Divers

- Necessity of saturation diving
  - Underwater gas and oil pipelines
  - No need for repetitive decompression/ which in return becomes energy efficient
  - Cost efficient

- Increased daily expenditure in saturation
  - Body burns more energy in sat.
  - Dependent on work being performed

- Physical challenges
  - Immunosuppression
  - Reduce in body mass
  - Reduced musculoskeletal health
  - Impaired cognition



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RJ (JJ) The Assessment of Daily Energy Expenditure of Commercial Saturation Divers Using Doubly Labelled Water. *Frontiers in Physiology*, *11*, 1–7. https://ezproxyprod.ucs.louisiana.edu:2443/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,cookie,uid,url&db=edb&AN=150543556&site=eds-live&scope=site

Saturation Diving and The Air in Your body

- Compression
  - PPO2 (partial pressure of oxygen) increases as you descend
  - Upon descent your switched to a Heli-ox mix of air
  - Decreased O2 percentage as you descend due to PPO2 levels
- Air in your body
  - Gas bubbles shrink
  - Lungs shrink
  - Start off-gassing Nitrogen
- Controlled ascent
  - Slow ascent
  - Fast ascent can cause bubbles to expand too rapidly
  - Large bubbles can cause AGE's (arterial gas embolisms)

https://images.app.goo.gl/13robLBrLXvBoqVV7

RJ (JJ) Jean-Pierre Imbert, Salih-Murat Egi, & Costantino Balestra. (2022). Vascular Function Recovery Following Saturation Diving. *Medicina*, *58*(1476) 1476
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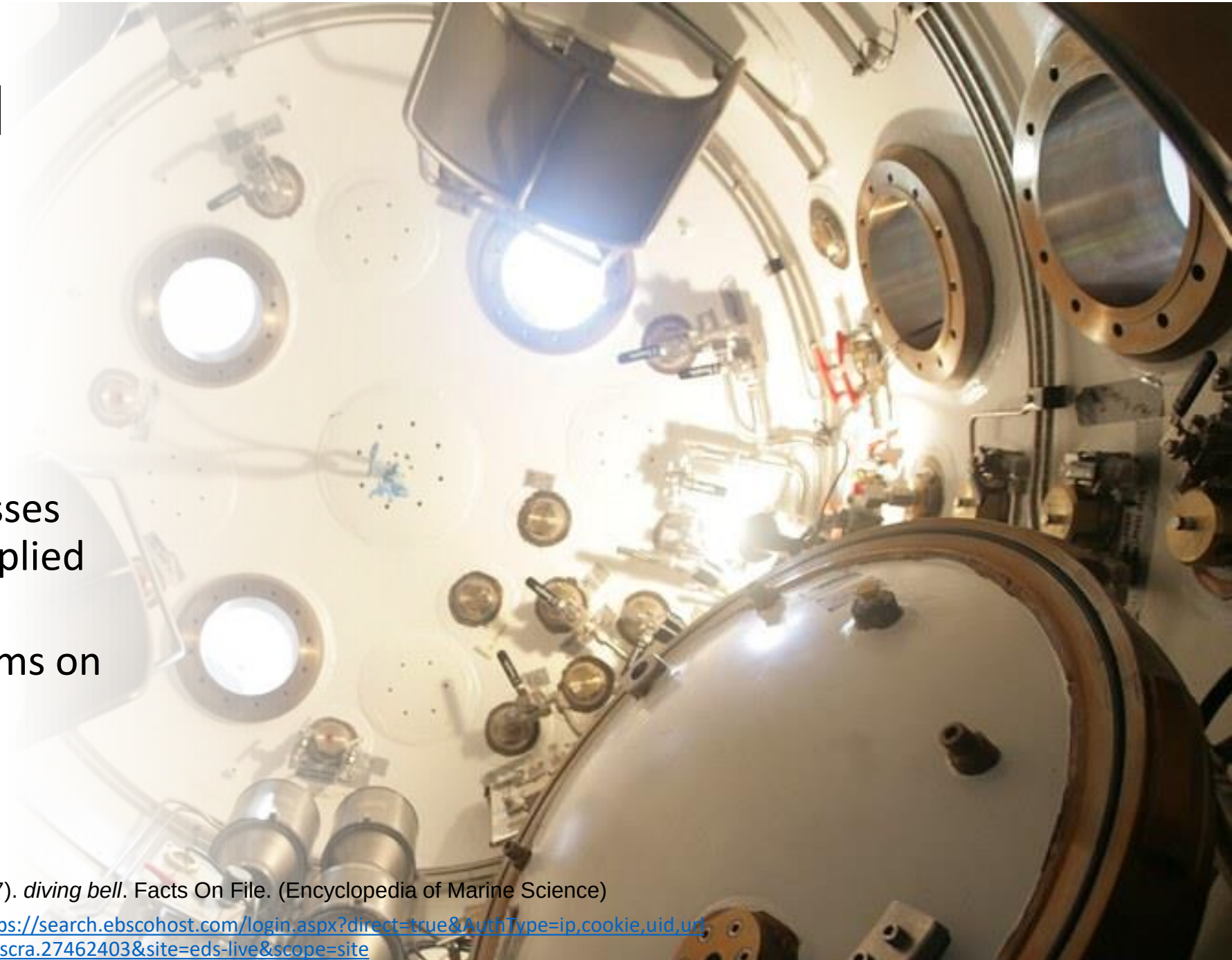
Dive Bells and Saturation



- Dive bells
  - Dive bells are watertight
  - Air filled with gasses from surface supplied hoses
  - Emergency systems on board
  - 2-3 man teams

Book: Nichols C., & Williams Robert. (2017). *diving bell*. Facts On File. (Encyclopedia of Marine Science)
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Closed Circuit

- Closed Circuit
  - Gas is inhaled by diver
  - Upon exhale expelled gasses sent through reclamation system with a C02 scrubber
  - Reclaimed and mixed with the correct gasses
  - Sent back to the diver (no bubbles)

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Impact of Saturation Diving

- Saturation diving is done in deep water
- Mostly for oil and gas companies
- No divers in the water for these companies, prices start going up
- Divers also provide routine maintenance on platforms and pipelines

MAG: Rich, N. (2013, February 7). Diving deep into danger. *The New York Review of Books*, *60*(2), 20. https://ezproxyprod.ucs.louisiana.edu:2443/login?url=https://search.ebscohost.com/login.aspx?direct=true&AuthType=ip,cookie,uid,url&db=edsgao&AN=edsgcl.321479015&site=eds-live&scope=site

Bodily Changes

Saturation divers' bodies go through changes while they are in sat and shortly after sat

All the nitrogen that is breathed on the surface is expelled and replaced with only helium and oxygen

Down to the molecular level of their bones and teeth

NEWS: New Findings from Nantong University in the Area of Occupational and Environmental Medicine Reported (Changes In the Gut Microbiota During and After Commercial Helium-oxygen Saturation Diving In China). (2019, December 20). *Genomics & Genetics Weekly*, 281

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Workday

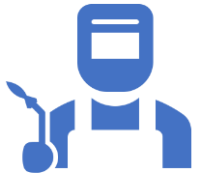
Saturation divers work alone or in two-man teams

Larger companies with larger DSV's can support two divers being in the water and one in the bell

Smaller companies can have one in the bell and one in the water

One person is in the bell (bellman)

This person monitors gauges and usually reads to pass the time



Usually 6-8 hour shifts on bottom or jobsite

Jobsite can be on hard bottom (sea floor)

Job can be along the side of a platform

WEB: (2018, May 9). *The weird, dangerous, isolated life of a saturation diver*. Atlasobscura. https://www.atlasobscura.com/articles/what-is-a-saturation-diver

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Decompression

- Decompression rates for saturation diving
  - Varies based on depth
- Saturation divers are reintroduced to nitrogen only when back at surface level
  - Too fast of an ascent can cause decompression sickness or an AGE
- Immediately sent on a table 6 decompression table on the decompression chamber.
  - Pinpoint pain in a specific area is a sign of an AGE

Pulling Everything Together

01

Underwater diving has come a long way from where it started as freediving to where it is now with saturation diving.

02

There has been a lot of learning from mistakes as mankind has ventured into the unknown world of underwater and the science behind it.

03

Saturation divers have to be mentally resielent and in good physical health.

Conclusion

- By following these protocols:
  - Obtaining required certifications
  - Wearing the correct gear
  - Understanding the science and physics of diving
  - Following the correct steps of launch and recovery of the bell and dive teams

- Saturation diving is not as dangerous as when mankind first explored underwater diving

Questions?