EXECUTIVE SUMMARY – USN DIVE MANUAL REVISION 7

NAVSEA 00C appreciates those that have contributed changes to this revision and those that provided feedback on changes to make this a better manual. We know it was no small task to set aside your day job to attend to a request to review this manual.

The Diving Operations Assessment / Integrated Project Team was formed by direction from the Chief of Naval Operations in October 2014 in the wake several diver deaths.

Its mission was to "conduct a holistic review of the Navy Diving Program for compliance with the requirements of references (a) and (b) [Dive manual and OPNAVINST 3150.27B] throughout the chain of command with particular focus on supervisory accountability. Integral to this effort was an assessment of the culture within the diving community, as it affects our ability to adequately assess operational readiness, effectively plan missions, accurately apply operational risk management, safely execute dives, and apply lessons learned."

Many, but not all, of the changes in this revision stem from DOA/IPT findings.

With this revision, in addition to updating technical information in accordance with OPNAVINST 3150.27 (series), correcting errors, and improving readability we sought to:

1. Give the Fleet more control over their diving force:

    A. We sought to provide a better planning process and guidance on how to dive instead of providing more rules to follow.
    B. NAVSEA can, and does, provide engineering and medical "rules" based on physics and physiology to keep our divers safe.
    C. NAVSEA cannot manage operational risk by providing rules for every situation a dive supervisor may face – our force is too diverse.
    D. Replacing rule-based decision-making with analytical decision-making, where possible, returns operational risk decisions to the Fleet.

2. Strengthen the Diving Supervisor:

    A. As the primary person responsible for executing safe and effective diving, the dive supervisor is the person most able to prevent mishaps.
    B. Not every dive side has a Diving Officer or a Master Diver, but every side has a Diving Supervisor.
    C. There are a number of changes intended to provide the dive supervisor, and the overall dive team, with effective tools to accomplish their mission, including:

        i. Updated planning and ORM information in chapter 6;
        ii. Information about non-diving supervisory skills from NEDU's TR 05-09;
        iii. Consolidated emergency procedures;
        iv. New and updated checklists – particularly for SCUBA diving.
        v. Improve readability.

The dive manual is, among other things, the ND rate-training manual. We owe our future divers the best resource we can give them to learn and apply their chosen trade. To this aim, we reduced redundancies and increased readability by consolidating information to

one location, clarified material and breaking long unwieldy paragraphs into bullets where possible. We moved information to the most relevant chapters (all SCUBA information is in the SCUBA chapter etc.)

1. ***Keep information isolated to a single location to reduce redundancies.***
2. ***Move information to its most relevant location (all SCUBA info to the SCUBA chapter etc.).***
3. ***Broke up long unwieldy paragraphs into bullets where possible.***

This revision deleted three chapters from revision 6: Chapter 12 Mixed Gas Diving Theory (formulas were integrated into chapter 2); Chapter 13 Mixed Gas Operational Planning (relevant information was combined with chapter 14 Surface Supplied Mixed Gas Diving); and Chapter 17 MK 16 Mod 0 Closed Circuit Mixed Gas UBA.

Diving Summary of changes by Volume and Chapter:

Front Matter

- Updated list of effective pages, certification sheet, foreward, safety summary, table of contents, list of illustrations, and list of tables.

Volume 1

No change.

Chapter 2. Underwater Physics

- 2-12. Gas Mixtures:
  - Adjusted explanation of Dalton's law and added/edited sample problems.
  - Reworded explanation of SEV for clarity and added sample problems.
  - Reworded explanation and formula for expressing small quantities of pressure.
  - Added expressing small quantities of volume (ppm)
- Table 2-11:
  - Minor conversion corrections.

Chapter 3. Underwater Physiology

- 3-5.4. Drowning/near drowning:
  - "Providing effective airway, breathing, and circulation interventions and immediate evacuation to a critical care facility (hospital) is a priority over recompression treatment" – aligns with new guidance on drowning in chapter 19 (formerly chapter 20).

Chapter 4. Dive systems

- 4-2.1:
  - Added system drawings to document precedence. Drawings are authoritative and in some cases may be the only place that a particular piece of information may be found
- 4-2.2:
  - AMU changed to ANU. ANU categories changed from three to two.
- 4-2.6:
  - Clarified use of OPs/EPs. Removed CO signature from cover page.
- 4-3. Diver's Breathing Gas Purity:
  - Replaced tables 4-1/4-2 with one combined air purity standard provided in new table 4-1.
  - Unit Commanding Officers may authorize use of civilian air when a military source is not available IAW NAVSEA HPAC evaluation checklist. Checklist recommends air analysis with a PAM. This change does not authorize use of civilian air in certified systems – only DP or SCUBA dives above 37 degrees F.
- 4-4.4:
  - Clarified PAM usage. Still does not replace air sampling program.
- 4-5. Dive System Components:
  - Added general dive system component (compressors, volume tank, pressure regulators, etc.) info from chapter 8. Chapter 8 is a chapter on surface supplied diving – not dive systems (related, but separate).

Chapter 5. Dive Program Administration. This chapter has been completely revised.

- Revised mishap/near mishap reporting terminology, requirements, and procedures:
  - OPNAVINST 5102.1D is in the process of being revised to require further fidelity on dive mishap/near-mishap reporting as reflected in this chapter. Numerous examples of reportable near-mishaps are given in the dive manual. The intent is not to require reporting of every hold or squeeze from a diver in the water but to collect meaningful data over time. Currently the diving community only collects class A mishap data. Trend analysis to prevent mishaps cannot be conducted when the only leading indications are class A mishaps.
- Updated failure analysis reporting.
- Revised chamber log requirements.
- Revised Appendix 1A Safe Diving Distances from Transmitting SONAR:
  - Fig 1A1 and paragraph 1A-4.2 Revised worksheet and formulas dealing with multiple SONARs or multiple exposures to clarify calculations
  - Transposed SONARs types and SPL/PELs in tables to facilitate calculations.

<u>Volume 2</u>

Chapter 6. ORM/Operational Planning. This chapter is completely revised.

- The current dive planning process is replaced with the Navy Planning Process from NWP 5-01 that integrates ORM from OPNAVINST 3500.30(C). Information from the NWP and OPNAV instruction is incorporated into this chapter to translate these processes to diving and effect changes to dive curriculum and PQS. A significant amount of planning information from Revision Six is retained in this chapter; however, much of the SCUBA and surface supplied specific information is moved to their respective chapters to make this chapter less air diving specific and more relevant to all diving.

Overview of changes:

- 6-2. Navy Planning Process:
  - Revised types of air diving (SCUBA, MK-20, KM-37) to four diving techniques: Breath hold diving (with increased guidance), free swimming self-contained UBA, SSD, and Saturation diving.
- 6-4. Course of Action Analysis/Risk Assessment:
  - Incorporated "risk management rules to remember" from the Naval Aviation Safety Program (OPNAVINST 3750.6R)
- 6-5. Task Planning and Emergency Assistance:
  - Added guidance on work-up dives.
  - Recompression chamber levels are provided as guidance, not a requirement, for operational commanders. Chambers should be placed in proximity to the dive location according to the risk of the mission. Risk in diving is dependent on a number of factors but the current chamber levels are based on time and depth only. A dive in 20 fsw while training a new team in SCUBA on dry suits may carry more risk than an experienced team performing SSD to 130 fsw in warm, clear, calm water. Often training dives carry more risk than operational dives due to untrained or non-proficient divers. Therefore, one may need to have a closer chamber than what is otherwise specified under previous rules.
  - Non-U.S. Navy certified chamber may be used to meet chamber requirement w/Commanding Officer OR Flag Officer authorization.
  - Added distinction between a medical facility and critical care facility.
  - Added verbiage for Dive Supervisors to potentially bypass treatment in a recompression chamber and medically treat in a critical care facility in the case of near drowning, major trauma, and rapid onset of paralysis.
- 6-6. Transition:
  - Clarified/defined mission briefs/dive briefs to align with current practice.
  - Added Time Critical Risk Management (TCRM) in the execution phase of an operation.
  - Added information for Dive Supervisors from NEDU report TR 05-09: Situational awareness (SA), decision-making, fatigue, and stress. Dive supervisors manage

and supervise complex and dangerous evolutions. This information equips dive supervisors to accomplish their tasks safely.

Chapter 7. SCUBA.

- 7-2. Added Operational Considerations. Subsequent sections shifted down (paragraph numbers here refer to new paragraphs):
  - Added operational limits and minimum manning from chapter 6.
  - Revised permissions verbiage regarding diving deeper than 130fsw
  - Clarified OIC authority.
  - Included civilian diver OSHA restrictions.
  - Submersible pressure gauge required, with or without a J valve.
  - Removed 100 scf air requirements when diving below 100fsw – air calculations required instead.
  - Added/consolidated duties and responsibilities of positions.
  - Standby diver should be a fully qualified and experienced diver (Safeguard and MDSU-2 Class A mishaps had the most junior (and inexperienced) divers as standby).
  - Standby required to remain ready to deploy.

- 7-3/7-4. SCUBA Equipment:
  - Revised description of SCUBA equipment/components.
  - Octopus is optional except for standby diver.
  - Submersible pressure gauge is required equipment.
- 7-3.7:
  - Added guidance on fin selection (split fins not recommended – Healy Class A mishap).
- 7-4.1:
  - Added guidance on use of wetsuits/dry suits.
- 7-4.1.7:
  - Clarified use of lifelines:
  - Minimum float is an 11-inch buoy.
  - Tending line is secured snugly around a diver's waist or connected to a harness worn under the SCUBA.
  - Lifelines used with buddy lines may introduce fouling hazard
- 7.4.1.10:
  - Added reference to Navy Dive Computer appendix.
- 7.4.1.11:
  - Independent secondary air source SHALL be considered by Dive Supervisors.
  - Smaller than 50scf cylinders authorized as independent secondary air source. (50scf cylinder still minimum size authorized as primary air sources).

- 7-5. Air Supply:

- Added additional guidance in calculating air supply.
- Removed 100 scf air supply rule. Dive Supervisors shall calculate required air supply for divers and standby. An arbitrary rule is no substitute for calculating air supply duration.
- Revised guidance on calculating effects of temperature differences.

- 7-6. Pre-dive Procedures:
  - Added SCUBA dive station setup checklist.
  - Added SCUBA Dive Supervisors checklist.

- 7-7. Water Entry:
  - Removed rear step entry
  - In-water check – check buoyancy – lower tools on a line if required.

- 7-8. Underwater Procedures:
  - Hose and mouthpiece clearing updated to Regulator clearing
  - Moved buddy diver responsibilities to section 7-2
  - Consolidated and added missing SCUBA emergency equipment (lost diver kit and recall).

- 7-8.9. Emergency Procedures. Consolidated procedures in this one location:
  - Added safety and emergency drill guidelines.
  - Specified lost diver kit requirements.
  - Lost diver procedure.
  - Trapped diver procedure.
  - Loss of air procedure. Included option of switching to independent air source.
  - Unconscious diver on the bottom procedure.

7-9. Ascent Procedures:
- Moved updated/clarified buddy breathing procedure (after EPs).
- Moved Emergency Free ascent procedure here

7-9.2.

- Requires tending lines during limpet search training, but not live limpet neutralization.

Chapter 8. Surface Supplied Diving

- 8-2. Added Operational Considerations. Subsequent sections shifted down (paragraph numbers here refer to new paragraphs):
  - Added operational limits from chapter 6.
  - Removed reference to CNO authorization (new OPNAVINST 3150.27)
  - Included civilian diver restrictions for SSD

- Moved OIC verbiage to 130fsw line
- Clarified OIC authority
- Added minimum manning from chapter 6.

- 8-2.2. Manning:
  - Added/consolidated duties and responsibilities of each dive station position.
  - Increased minimum personnel for Divator and Surfaced Supplied Air Diving to six
  - Added watch station Diving Officer shall be PQS qualified.
  - Added ORM assessment requirement by the Dive Supervisor for each diving day.
  - Specified that the standby diver should be a fully qualified and experienced diver (Safeguard and MDSU-2 Class A mishaps had the most junior diver as standby).

- 8-3. KM-37:
  - Reduced redundant and incomplete sample problems.
  - Moved EGS requirements to end of discussion about air supply.
  - Corrected error in EGS setting when left topside from 135psi to 150 psi.
  - Removed MK-21 terminology

- 8-4. MK-20:
  - Clarified differences and use of MK-20 Mod 0 and Mod 1

- 8-5. Portable Surface Supplied Diving Systems:
  - Moved dive systems component info to chapter 4 (Dive Systems).
  - Reduced discussion of standard dive systems - refers to equipment tech manuals
  - Added DP information from chapter 6.
  - Clarified DP configurations and use.
  - Reduced MK-3 Configurations.

- 8-6. Surface Supplied Diving Accessory Equipment:
  - Provided additional information on accessory equipment (Diver's handling systems, stage, ladder, etc.)

- 8-8. Predive procedure.
  - Added setting a moor. (Dynamic positioning guidance)
  - Added verify environmental conditions
  - Added (revised) Surface Supplied Dive Station Setup checklist (from chapter 6).

- 8-10. Underwater Procedures:
  - Replaced procedure for searching on the bottom w/ circling line.
  - Modified note on safety.
  - Added loss of communications and loss of gas supply to EP section.
  - Moved disadvantages of in-water decompression to chapter 9.

Chapter 9. Air Decompression

- Table 9-9. REPLACED DIVE TABLES WITH NEW VVAL-79 AIR TABLES to correct profiles know to have caused issues with above average risk of DCS.
- Added disadvantages of in-water decompression from chapter 8.
- Updated dive charts (Figures 9-3 through 9-14) with new VVAL-79 Air Tables.

Chapter 10. NITROX Diving

No change

Chapter 11. Ice Diving

- 11-2. Operational Planning:
  - Replaced the phrase "at or below 37 degrees F" with " below 37 degrees F and colder"
  - Added recommendation to attend Cold Water Ice Diving Course.
  - Added DP as one of three redundant air source configurations when diving SCUBA. Amplified each configuration.
  - Included use of harnesses with lifelines.
  - Hot water shroud for KM37 required.
  - Added additional References

Appendix 2A. Optional Shallow Water Diving Table

No change

Appendix 2B. Navy Dive Computer

- Consolidated Navy Dive Computer information in one location.
- Created new Emergency procedures for use with the NDC

Appendix 2C. Operational Hazards and Environmental hazards

- Consolidated hazards to provide a single location and ready reference for diving hazard information.
- Enclosed space SCUBA diving authorized to save human life or recover items of such importance as to warrant the risk of potential loss of additional life.

Appendix 2D. Guidance for U.S. navy Diving on a Dynamic Positioning Vessel

- Added new appendix to provide additional guidance for diving on a dynamic positioning vessel.

Volume 3

Chapter 12. Mixed Gas Diving Theory – Deleted.

Rationale: This chapter served as a refresher or "advanced" physics for mixed gas diving when the procedures for air and mixed gas diving were very different and diving was a collateral duty. With promulgation of Rev 5 in 2008 the differences between the two modes of diving were significantly diminished. The formulas between chapters 2 and 12 were redundant in some areas and incomplete in others. The sample problems from both chapters were combined in chapter 2 to provide one complete set of formulas that covered most variables.

Chapter 12. Surface Supplied Mixed Gas Diving (Formerly chapter 13)

- Deleted redundant planning information.
- Added additional information on thermal considerations.
- Table 12-4 Surface Supplied Mixed Gas Dive Team (manning levels):
    - Master Diver required on mixed gas dive station.
    - No single person may serve in more than one position at a time (MDV may not fill the MDV position and Diving Officer position)
    - DMT required on station. DMO should be on station.
    - No net change to manning levels (DMO and DMT were previously counted – now only DMT).

Chapter 13. HEO2 SSD Deleted – material combined with Chapter 12

Chapter 13. Saturation Diving (Formerly chapter 15)

- Added SATFADS.
- 13-20.1:
    - Updated helium-oxygen methods 1 through 3.
- 13-8.2:
    - Updated calculations for emergency gas supply duration
- Table 13-2:
    - Updated and revised applicable names for saturation dive watch stations.
- Revised text and pictures.

Chapter 14. Breathing Gas Mixing Procedures (Formerly chapter 16)

No change

Volume 4

Chapter 15. Electronically Controlled Closed Circuit Underwater Breathing Apparatus (EC-UBA) Diving (Formerly Chapter 17 and 18 - MK 16 Mod 0 and Mod 1).

- Rewrote to refer to generic underwater breathing apparatus rather than specific UBA (i.e. MK-16).
- Combined chapters to reduce redundancies in the Dive Manual.
- Readers are referred to equipment technical manuals for rig specific information.
- 15-3. Operational planning:
  - Removed MCM tactic specific information. This information more appropriately resides at the unit/ISIC/TYCOM level.
  - If divers have been inactive and operating conditions permit, workup dives are strongly recommended.
  - Qualification on one rig (Mod 0 or Mod 1) may transfer to the other by CO's direction.
  - Added CO or OIC approval to dive w/out tending line/buddy line.
  - Distance line changed from 81 to 100 feet
  - Revised guidance for SCUBA as stand by diver. Removed 130fsw limit – limits IAW chapter 7.
  - Single diver in training environment shall be tended/marked.
- 15-9. Multi-day diving:
  - Contact NAVSEA 00C vice NEDU for additional time.
- 15-12. Medical aspects:
  - Refers readers to chapter 3 for CNS symptoms.
- Decompression tables from chapters 17 and 18 included in chapter 15.
- Appendix 4A deleted. Material incorporated within text of chapter 15.

Chapter 16. Closed Circuit oxygen UBA Diving (Formerly Chapter 19)

- Rewrote the chapter to refer to generic closed circuit oxygen rigs.
- Refers readers to chapter 3 for physiological problems causes and symptoms (CNS toxicity, hypercapnia, hypoxia, etc.).
- Removed MK-25 rig specific info – refers to O&M manual.
- Removed CO2 absorbents and canister limits - refers to O&M manuals.
- 16-3:
  - Clarified transits and excursions.
- 16-4:
  - Added verbiage related to MCM and combat diving situations –Deviations from buddy lines witness float requirement made and documented at the major command level.
- 16-10:
  - Included MK-25 characteristics at end of chapter.

Volume 5

Chapter 17. Diagnosis and Treatment of Diving Disorders. (Formerly chapter 20)

- 17-2. Manning Requirements:
  - Added section and table at the front of the chapter.
  - Added recommended ideal chamber team along with minimum and emergency. No net change to manning requirements.
  - Added description of duties/responsibilities.
- 17-3.3:
  - Revised treatment of pulseless diver. Evacuate a pulseless diver to ACLS/critical care facility vice treat in a recompression chamber.
- 17-9.5:
  - Replaced guidance for returning to diving after treatment with verbiage to direct divers to DMO for clearance prior to returning to diving.
- Updated Figure 17-1 for paragraph 17-3.3.
- Table 17-9:
  - Added series number of pulse oximeter under miscellaneous.

Chapter 18 Recompression Chamber Operation (Formerly chapter 21)

- Table 18-1. Navy Recompression Chamber Support Levels:
  - Recompression chamber levels are provided as guidance, not a requirement, for operational commanders. Chambers should be placed in proximity to the dive location according to the risk of the mission. Risk in diving is dependent on a number of factors but the current chamber levels are based on time and depth only. A dive in 20 fsw while training a new team in SCUBA on dry suits may carry more risk than an experienced team performing SSD to 130 fsw in warm, clear, calm water. Often training dives carry more risk than operational dives due to untrained or non-proficient divers. Therefore, one may need to have a closer chamber than what is otherwise specified under previous rules.
  - Non-U.S. Navy certified chamber may be used to meet chamber requirement w/Commanding Officer OR Flag Officer authorization.

Appendix 5A

No change

Appendix 5B

No change

Appendix 5C

- Updated Dangerous marine mammal references.