

Surface-Supplied Mixed-Gas Diving Procedures

14-1 INTRODUCTION

14-1.1 Purpose. The purpose of this chapter is to familiarize divers with U.S. Navy surface-supplied procedures.

14-1.2 Scope. Surface-supplied mixed-gas diving is conducted with helium-oxygen mixtures supplied from the surface by a flexible hose. Surface-supplied mixed-gas diving is particularly suited for operations beyond the depth limits of air diving, yet short of the depths and times requiring the use of a deep diving system. Surface-supplied mixed-gas diving is also useful in the deep air diving range when freedom from nitrogen narcosis is required.

14-2 PLANNING THE OPERATION

Planning surface-supplied mixed-gas dives involves many of the same considerations used when planning an air dive. Planning aspects that are unique to surface-supplied mixed-gas diving include the logistics of providing several different gas mixtures to the diver and the limitations on the duration of carbon dioxide absorption canisters in cold water.

14-2.1 Depth and Exposure Time. The normal operational limit for surface-supplied mixed-gas diving is 300 fsw. Within each decompression table (Table 14-7), exceptional-exposure dives are enclosed in red boxes to separate them from normal working dives. Exceptional-exposure dives require lengthy decompression and are associated with an increased risk of decompression sickness and exposure to the elements. Exceptional exposures should be undertaken only in emergency circumstances. Planned exceptional-exposure dives require prior CNO approval. Repetitive diving is not allowed in surface-supplied helium-oxygen diving.

14-2.2 Water Temperature. Loss of body temperature (hypothermia) can be a major problem during long, deep dives. Because the high thermal conductivity of helium in a dry suit accelerates the loss of body heat, a hot water suit is preferred for surface-supplied dives when using the MK 21 MOD 1 in very cold water.

Refer to Chapter 3 for more information on thermal problems and the signs and symptoms of hypothermia. Refer to Chapter 11 for information on ice and cold water diving operations.

14-2.3 Gas Mixtures. Air, 100 percent oxygen, and several helium-oxygen mixtures will be required to dive the surface-supplied mixed-gas tables over their full range. The logistics of supplying these gases must be carefully planned. Analysis of the

oxygen content of helium-oxygen mixtures shall be accurate to within ± 0.5 percent.

- 14-2.3.1 **Maximum/Minimum Mixtures.** For each depth in the decompression tables, the allowable maximum and minimum oxygen percentage in the helium-oxygen mixture used on the bottom is specified. For operations planning, the range of possible depths should be established and a mixture selected that will meet the maximum/minimum specification across the depth range. The maximum oxygen concentration has been selected so that the diver never exceeds an oxygen partial pressure of 1.3 ata while on the bottom. The minimum oxygen percentage allowed in the mixture is 16 percent for depths to 200 fsw, 12 percent for depths from 200 fsw to 300 fsw, and 10 percent for depths in excess of 300 fsw. Diving with a mixture near maximum oxygen percentage is encouraged as it offers a decompression advantage to the diver.
- 14-2.3.1.1 **On the Surface.** On the surface, the diver's gas mixture must contain a minimum of 16 percent oxygen. When a bottom mix with less than 16 percent oxygen is to be used, a shift to the bottom mix is made at 20 fsw during descent (see paragraph 14-3.2).
- 14-2.3.1.2 **Deeper than 200 fsw.** For dives deeper than 200 fsw in which the bottom mixture contains less than 16 percent oxygen, a gas shift from the bottom mix to a 60 percent helium/40 percent oxygen mixture is required at the 100-fsw decompression stop or the next shallower stop if there is no 100-fsw stop (see paragraph 14-3.3).
- 14-2.3.1.3 **Up to 200 fsw.** For dives to 200 fsw and shallower or for deeper dives in which the bottom mixture contains more than 16 percent oxygen, a shift to 60 percent helium/40 percent oxygen is not required but can be executed to increase decompression safety if desired.
- 14-2.3.1.4 **Exceptional Exposure Dives.** For exceptional-exposure dives, a shift to a 60 percent helium/40 percent oxygen mixture is required at the 100-fsw stop or the next shallower stop if there is no 100-fsw stop.

On all dives, a shift to 100 percent oxygen is made at the 50-fsw or 40-fsw water stop if there is no 50-fsw stop.

- 14-2.3.2 **Emergency Gas Supply.** All divers are equipped with an emergency gas supply (EGS). The EGS gas mixture will be the same as the bottom mixture unless the bottom mixture contains less than 16 percent oxygen, in which case the EGS gas mixture will be 16 + 0.5 percent oxygen and the balance will be helium. The EGS bottle shall be a minimum of 64.7 (steel 72) cubic feet charged to 1,800 psi.

14-3 SURFACE-SUPPLIED HELIUM-OXYGEN DESCENT AND ASCENT PROCEDURES

The Surface-Supplied Helium-Oxygen Decompression Table (Table 14-7) is used to decompress divers from surface-supplied helium-oxygen dives. The table is in a depth-time format similar to the U.S. Navy Air Decompression Table and is used

in a similar fashion. One additional table, the Emergency Procedures Decompression Table (Table 14-1), is used under emergency conditions (see paragraph 14-4.4).

Table 14-1. *Emergency Procedures Decompression Table.*

Decompression Stop Depth (fsw)	Decompression Stop Time (min)
50	30
40	35
30	42
20	52
10	68

14-3.1 Surface-Supplied Helium-Oxygen Decompression Table. The Surface-Supplied Helium-Oxygen Decompression Table (Table 14-7) specifies the maximum and minimum concentrations of oxygen allowable in the helium-oxygen mixture at depth. Select a gas mixture for the dive that is compatible with the deepest depth anticipated for the dive.

14-3.1.1 Calculating Maximum Depth. To select the proper decompression table and schedule, measure the deepest depth reached by the diver and enter the table at the exact or next greater depth. When using an air-filled pneumofathometer to measure depth, the observed depth reading must be corrected as shown in Table 14-2. It is also important that the pneumofathometer be at mid-chest level. Enter the table at the maximum or next greater depth. It is also important that the pneumofathometer be at mid-chest level. The bottom time is measured as the time from leaving the surface to leaving the bottom, rounded up to the next whole minute, except as noted in paragraph 14-3.2. Enter the table at the exact or next greater bottom time.

Table 14-2. *Pneumofathometer Correction Factors.*

Pneumofathometer Depth	Correction Factor
0-100 fsw	+1 fsw
101-200	+2 fsw
201-300	+4 fsw
301-400	+7 fsw

Example. The diver’s pneumofathometer reads 250 fsw. In the depth range of 201-300 fsw, the pneumofathometer underestimates the diver’s true depth by 4

fsw. To determine the true depth, 4 fsw must be added to the pneumofathometer reading. The diver's true depth is 254 fsw.

14-3.1.2 **Travel Rates.** The descent rate is not critical, but it should not exceed 75 fsw/min. The ascent rate is at a constant rate of 30 fsw/minute. The ascent time between stops is included in the time of the subsequent stop, except when reaching the first stop and when the shift to 100 percent oxygen is made.

14-3.1.3 **Decompression Breathing Gas.** For dives as deep as 200 fsw, decompression is taken on the bottom mixture up to the 50-fsw water stop (40-fsw if 40 fsw is the first stop) and the diver is then shifted to 100 percent oxygen. For dives greater than 200 fsw, decompression is taken on the bottom mixture to the 100-fsw water stop (or next shallower stop if there is no 100-fsw stop) and the diver is then shifted to a 60 percent helium/40 percent oxygen mixture. Upon arrival at the 50-fsw water stop, the diver is shifted to 100 percent oxygen. Surface decompression may be taken after completing a portion of the 40-fsw oxygen stop on all dives, as described in paragraphs 14-3.7 and 14-3.8.

14-3.2 **Special Procedures for Descent with Less than 16 percent Oxygen.**

14-3.2.1 **Descent Procedure.** To prevent hypoxia, a special descent procedure is required when the bottom mixture contains less than 16 percent oxygen:

1. Place the diver on the surface on air.
2. Make the appropriate pre-dive checks.
3. Have the diver descend to 20 fsw.
4. At 20 fsw, shift the diver to the bottom mix and ventilate. The diver is allowed 10 minutes at 20 fsw to shift to the bottom mixture and perform equipment checks.
5. Confirm the diver is on bottom mix, then perform a final leak check.
6. Have the diver begin descent. On the diving chart, note the time from leaving the surface to leaving 20 fsw in case the dive must be aborted during descent.
7. Start counting bottom time:
 - If the diver spends 10 minutes or less at 20 fsw, bottom time starts when the diver leaves 20 fsw.
 - If the diver spends more than 10 minutes at 20 fsw, bottom time starts at the 10-minute mark.

14-3.2.2 **Aborting the Dive.** If it is necessary to bring the diver back to the surface from 20 fsw:

1. Shift the diver from the bottom mixture to air.

2. Ventilate the diver.
3. Confirm the diver is on air.
4. Have the diver begin ascent.
5. When the diver reenters the water the 10-minute period begins again.

14-3.3 Procedures for Shifting to 60 Percent Helium/40 Percent Oxygen at 100 fsw.

For dives deeper than 200 fsw in which the bottom mixture contains less than 16 percent oxygen, it is necessary to shift from the bottom mixture to 60 percent helium/40 percent oxygen at 100 fsw during decompression or the next shallower stop if there is no 100-fsw decompression stop. Ventilate each MK 21 MOD 1 diver using the following procedures.

1. Ventilate each diver and listen for the gas-flow change over the communications.
2. Once a gas-flow change is heard, continue to vent for an additional 10 seconds. If a gas-flow change cannot be heard, ventilate for a minimum of 20 seconds.

The time required to effect the shift over to 40 percent oxygen is not critical.

14-3.4 Procedures for Shifting to 100 Percent Oxygen at the First Oxygen Stop. All dives except no-decompression dives require a shift to 100 percent oxygen at the 50-fsw stop, or at the 40-fsw stop if there is no 50-fsw stop. Upon arrival at the stop, ventilate each MK 21 MOD 1 diver with oxygen following these steps:

1. Ventilate each diver and listen for the gas-flow change over the communications.
2. Once a gas-flow change is heard, continue to vent for an additional 10 seconds. If a gas-flow change cannot be heard, ventilate for a minimum of 20 seconds.

Verify the diver's voice change. Time at the stop begins when the diver is confirmed to be on oxygen. When 50 fsw is the first oxygen stop, the ascent time from 50 fsw to 40 fsw is included in the time of the 40-fsw stop.

14-3.5 Ascent from the 40-fsw Water Stop. For normal in-water decompression, the diver surfaces from 40 fsw during the last minute of the 40-fsw stop. Ascent rate is 40 fsw/min. For example, if the 40-fsw stop is 68 minutes, the diver remains at 40 fsw for 67 minutes. During the last minute, he travels to the surface at 40 fsw/minute. Figure 14-1 shows the diving chart for this dive; the in-water decompression dive profile is shown in Figure 14-2.

14-3.6 Surface Decompression Procedures (SUR D). There are two types of surface decompression procedures, Normal SUR D and Emergency SUR D. Normal SUR

Date: 9-14-96	ppO ₂ : 1-26	Bottom Mix: 15%							
Diver 1: D. Roberts	Rig: MK-21	PSIG: 3000	O ₂ % 16	Left Surface: 0737					
Diver 2: G. Chancellor	Rig: MK-21	PSIG: 3000	O ₂ % 16	Left Surface: 0742					
Diver 3: M. Washington	Rig: MK-21	PSIG: 3000	O ₂ % 16	Table/Sched: 250/20					
Left Bottom: 0800	Total Bottom Time: :18	Reached Surface: 09:50::48		Reached Surface: N/A					
Total Decompression Time: 1:50::48			Total Time of Dive: 2:08::48						
Diving Supervisor (print): BMCM (SS/MDV) McMurtrie			Diving Supervisor (signature): PD McMurtrie						
Descent Rate (75 fpm max)	Emergency Decompression Table	Ascent Rate (30 fpm)	Stop Depth (fsw)	Decompression Time		Time			
				Water	Chamber	Water		Chamber	
	:68	.01	10			L		L	
						R		R	
.05	:52		20			L		L	
						R		R	
	:42		30			L		L	
						R		R	
	:35		40	:70-1-69		L	0949::48	L	
						R		R	
	:30	::20	50	:10	Shift to O ₂	L	0840::48		
						R	0830::48		
						L	0828::28		
						R			
						L	0821::28		
						R			
						L	0814::28		
						R			
						L			
						R			
					Shift to 60/40	L			
						R			
						L	0811::28		
						R	0804::28		
						L			
						R			
						L			
						R			
						L			
						R			
					Shift to 60/40	L			
						R			
						L	0800		
						R			
Stage Depth (fsw): 244'	Decompression Procedure: In-Water								
Max Depth (fsw): 249'	Divers' Condition: OK								
Diving Remarks:									

Figure 14-1. HeO₂ Diving Chart.

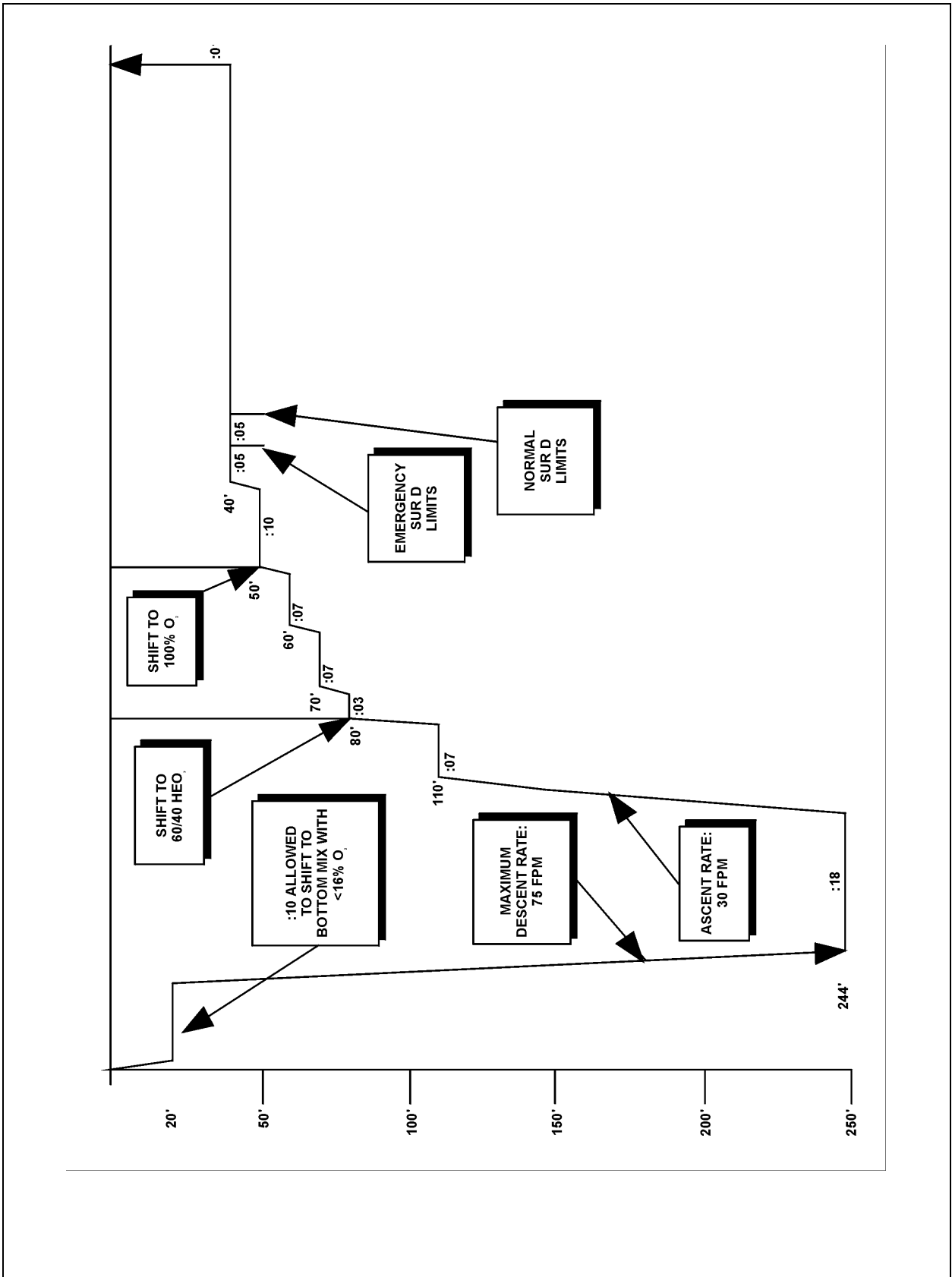


Figure 14-2. In-Water Decompression Dive Profile for a 249 fsw/:18 Dive.

D procedures are preferred over in-water decompression procedures in routine operations. Normal SUR D procedures improve the diver's comfort and safety but increase total decompression time and oxygen consumption. Emergency SUR Ds are used for handling CNS oxygen toxicity symptoms, systems failures and other emergency conditions. Emergency surface decompression allows the diver to be removed from the water in the shortest possible time.

14-3.7 Normal SUR D Procedures Using Oxygen. A diver is eligible for normal surface decompression if he has been on oxygen at 40 fsw for a length of time equal to that of the 50-fsw stop. If there is no 50-fsw stop, 10 minutes on oxygen at 40 fsw is required.

Example. If the 50-fsw stop time is 12 minutes, the diver must remain on oxygen at 40 fsw for 12 minutes before normal surface decompression can be implemented.

14-3.7.1 Initiating Normal Surface Decompression. To initiate normal surface decompression:

1. Bring the diver to the surface at 40 fsw/min and undress him.
2. Place the diver in the recompression chamber.
3. Compress on air to 40 fsw at a maximum compression rate of 80 fsw/min and place the diver on 100 percent oxygen by mask. The interval from leaving 40 fsw in the water to arriving at 40 fsw in the chamber cannot exceed 5 minutes.
4. At 40 fsw in the chamber, the diver breathes oxygen for 30-minute periods separated by 5-minute air breaks. The number of oxygen periods required depends on the time of the 40-fsw water stop as indicated in Table 14-3.

Table 14-3. Recompression Chamber Breathing Requirements.

Water Stop	Oxygen Breathing Period(s)
30 minutes or less	1 period
31–60 minutes	2 periods
61–90 minutes	3 periods
Greater than 90 minutes	4 periods

5. When the last oxygen breathing period has been completed, return the diver to breathing chamber air.
6. Ascend to the surface from 40 fsw in the chamber at a rate of 30 feet per minute.

A normal surface decompression dive chart is shown in Figure 14-3. A normal surface decompression dive profile is shown in Figure 14-4.

Date: <i>9-15-96</i>	ppO ₂ : <i>1-26</i>	Bottom Mix: <i>15%</i>							
Diver 1: <i>McMurtrie P.</i>	Rig: <i>MK-21</i>	PSIG: <i>3000</i>	O ₂ % <i>16</i>	Left Surface: <i>0737</i>					
Diver 2: <i>Chase, CDR</i>	Rig: <i>MK-21</i>	PSIG: <i>3000</i>	O ₂ % <i>16</i>	Left Surface: <i>0742</i>					
Diver 3: <i>Scholley, CDR</i>	Rig: <i>MK-21</i>	PSIG: <i>3000</i>	O ₂ % <i>16</i>	Table/Sched: <i>250/20</i>					
Left Bottom: <i>0800</i>	Total Bottom Time: <i>:18</i>	Reached Surface: <i>09:01::48</i>		Reached Surface: <i>10:47::08</i>					
Total Decompression Time: <i>2:47::08</i>		Total Time of Dive: <i>3:05::08</i>							
Diving Supervisor (print): <i>HTCM (MDV) Washington</i>			Diving Supervisor (signature): <i>M. Washington</i>						
Descent Rate (75 fpm max)	Emergency Decompression Table	Ascent Rate (30 fpm)	Stop Depth (fsw)	Decompression Time		Time			
				Water	Chamber	Water		Chamber	
	:68	:01	10		<i>1::20</i>	L		L	
						R		R	
<i>:05</i>	:52		20		<i>:04</i>	L		L	
						R		R	
	:42		30			L		L	
						R		R	
	:35		40	<i>(:20)</i>	<i>30/5/30/5</i>	L	<i>0900::48</i>	L	<i>1045::48</i>
				<i>:70-1=69</i>	<i>30-100</i>	R		R	<i>0905::48</i>
	:30	<i>::20</i>	50	<i>:10</i>		L	<i>0840::84</i>		
						R	<i>0830::48</i>		
			60	<i>:07</i>		L	<i>0828::28</i>		
						R			
		<i>:02::20</i>	70	<i>:07</i>		L	<i>0821::28</i>		
						R			
		<i>:20</i>	80	<i>:03</i>		L	<i>0814::28</i>		
						R			
		<i>:20</i>	90			L			
						R			
		<i>:01</i>	100			L			
						R			
			110	<i>:07</i>		L	<i>0811::28</i>		
						R	<i>0804::28</i>		
			120			L			
						R			
		<i>:04::28</i>	130			L			
						R			
			140			L			
						R			
			150			L			
						R			
		<i>:05 Shift to Bottom Mix</i>	160			L			
						R			
		<i>:02 Shift to 60/40</i>	170			L			
						R			
		<i>:02::20 to Travel</i>	180			L			
						R			
		<i>Shift and</i>	190			L			
						R			
		<i>Vent O₂</i>	<i>244'</i>	<i>190'</i>	<i>:18</i>	L	<i>0800</i>		
						R			
Stage Depth (fsw): <i>244'</i>	Decompression Procedure: <i>Normal SUR-D</i>								
Max Depth (fsw): <i>249'</i>	Divers' Condition: <i>OK</i>								
Diving Remarks:									

Figure 14-3. HeO₂ Diving Chart.

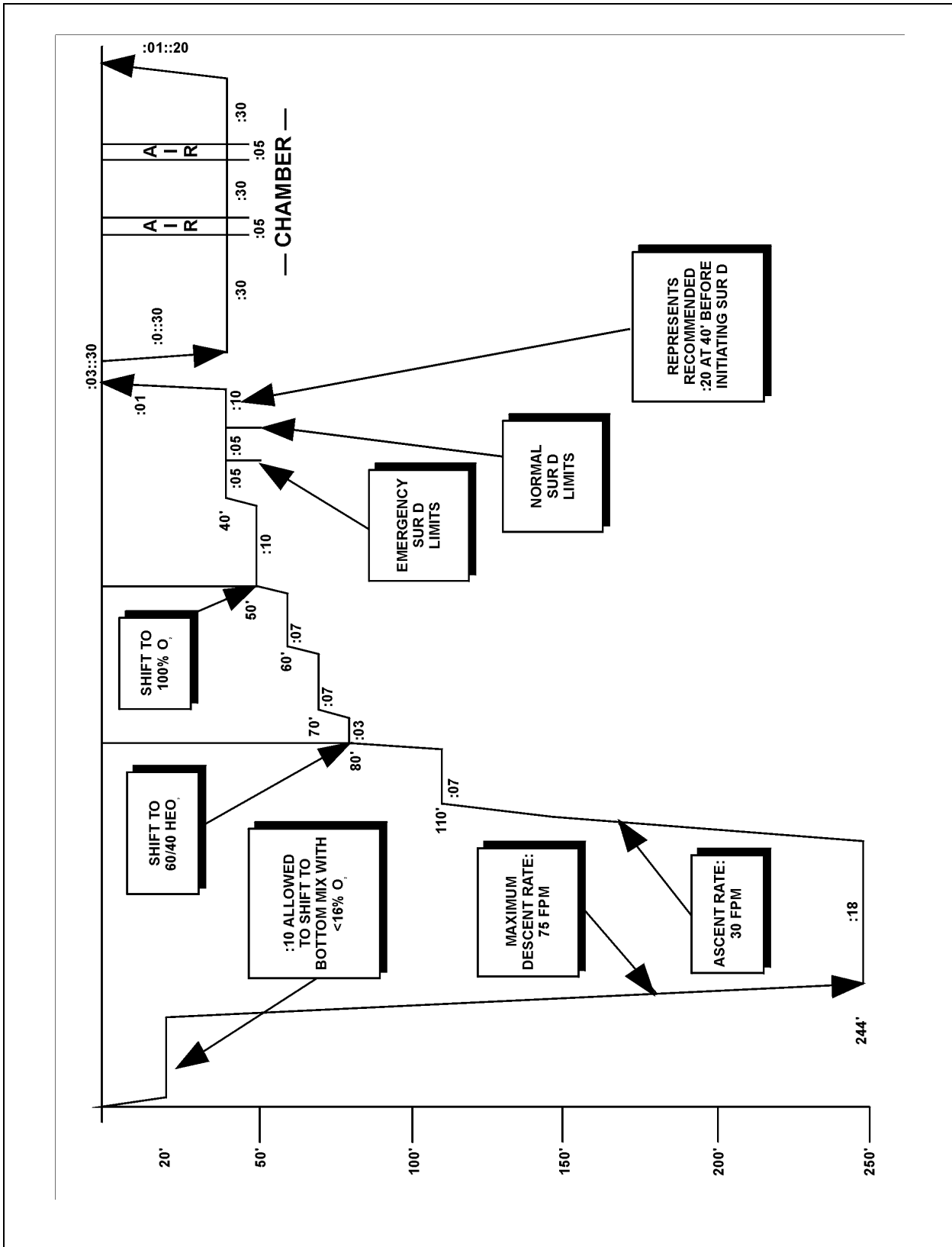


Figure 14-4. Normal Surface Decompression Dive Profile for a 249 fsw/:18 Dive.

14-3.8 Emergency SUR D Procedures Using Oxygen. A diver is eligible for emergency surface decompression if he is on oxygen at the 40-fsw water stop and is within 5 minutes of repeating the 50-fsw stop time. If there is no 50-fsw stop, 5 minutes on oxygen at 40 fsw is required.

Example. If the 50-fsw stop time is 12 minutes, the diver must remain at 40 fsw breathing oxygen for 7 minutes before emergency surface decompression can be initiated.

The emergency surface decompression procedure is identical to the normal surface decompression procedure except that the length of the first oxygen breathing period at 40 fsw in the recompression chamber is lengthened from 30 minutes to 40 minutes. An emergency surface decompression dive chart is shown Figure 14-5; the profile is shown in Figure 14-6.

14-3.9 Aborted Dive During Descent. Follow these procedures when a dive must be aborted during descent.

14-3.9.1 Dive Aborted at 200 fsw or Shallower.

- Add any time spent shifting gases at 20 fsw to the bottom time to derive a corrected bottom time.
- Enter the table at the deepest depth attained by the diver and select the schedule corresponding to the corrected bottom time.
- Decompress according to the indicated schedule.

14-3.9.2 Dive Aborted Deeper than 200 fsw.

- No correction of the bottom time for time spent at 20 fsw is needed.
- Enter the table at the deepest depth attained by the diver and select the schedule corresponding to the bottom time.
- Decompress according to the indicated schedule.

14-3.9.3 No-Decompression Limits. In many instances the diver will be observed to fall within the no-decompression limits when the above procedures are followed.

- If the diver falls within the no-decompression limits and is breathing at least 16 percent oxygen, surface the diver at 30 fsw/minute.
- If the diver falls within the no-decompression limits but is breathing less than 16 percent oxygen:
 1. Bring the diver to 20 fsw at 30 fsw/minute.
 2. Shift the diver to air and ventilate.

Date: 9-15-96	ppO ₂ : 1-26	Bottom Mix: 15%							
Diver 1: Mattioni L.	Rig: MK-21	PSIG: 3000	O ₂ % 16	Left Surface: 0737					
Diver 2: Dennis D.	Rig: MK-21	PSIG: 3000	O ₂ % 16	Left Surface: 0742					
Diver 3: Murphy B.	Rig: MK-21	PSIG: 3000	O ₂ % 16	Table/Sched: 250/20					
Left Bottom: 0800	Total Bottom Time: :18	Reached Surface: 08:46::48		Reached Surface: 10:42::08					
Total Decompression Time: 2:42::08			Total Time of Dive: 3:00::08						
Diving Supervisor (print): BMCM (SW/MDV) Frank			Diving Supervisor (signature): E. Frank						
Descent Rate (75 fpm max)	Emergency Decompression Table	Ascent Rate (30 fpm)	Stop Depth (fsw)	Decompression Time		Time			
				Water	Chamber	Water		Chamber	
	:68	:01	10		1:20	L		L	
:05	:52		20		:04	R		R	
	:42		30			L		L	
	:35		40	:05 :70-1=69	40/5/30/5 30-(110)	L	0845::48	L	1040::48
	:30	::20	50	:10		R		R	0850::48
			60	:07		L	0840::48		
			70	:07		R	0830::48		
			80	:03		L	0828::28		
			90			R	0821::28		
			100			L	0814::28		
			110	:07		R			
			120			L	0811::28		
			130			R	0804::28		
			140			L			
			150			R			
			160			L			
			170			R			
			180			L			
:03			190	:18		R	0800		
Stage Depth (fsw): 244'	Decompression Procedure: Emergency SUR-D								
Max Depth (fsw): 249'	Divers' Condition: OK								
Diving Remarks:									

Figure 14-5. HeO₂ Diving Chart.

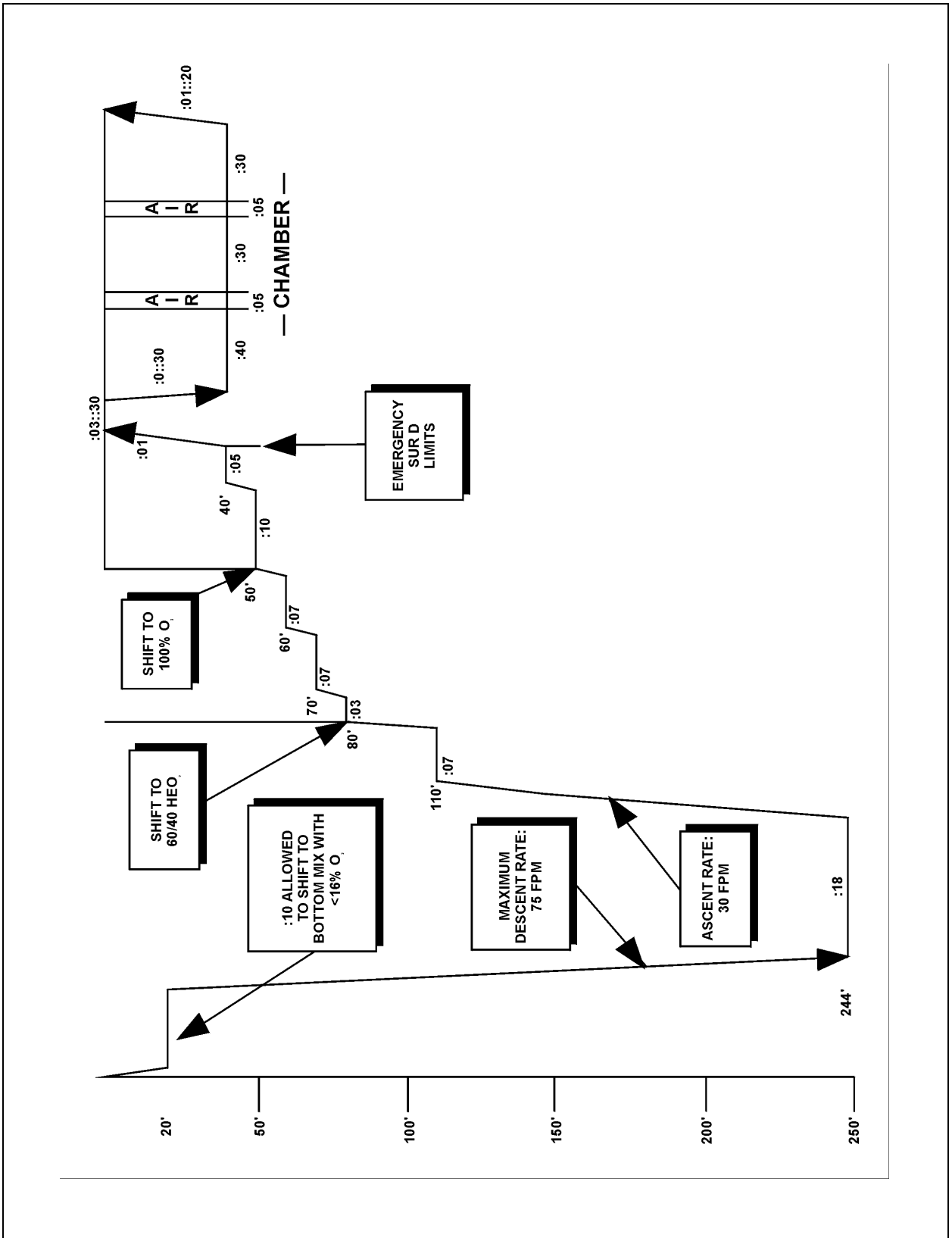


Figure 14-6. Emergency Surface Decompression Dive Profile for a 249 fsw/:18 Dive.

3. Surface the diver from 20 fsw when it is confirmed that the diver is breathing air.

Example. A diver intends to dive to 300 fsw. Five minutes is spent at 20 fsw shifting from air to an 88 percent helium/12 percent oxygen mixture. Descent is then begun at 60 fsw/min, but at 80 fsw the diver signals for a hold because he is unable to clear. After 2 minutes at 80 fsw, the dive is aborted. The bottom time is 3 minutes: 1 minute for the descent and 2 minutes at 80 fsw. The corrected bottom time is 8 minutes: 5 minutes at 20 fsw and 3 minutes of bottom time. The table shows an 80 fsw dive for 8 minutes is well within the no-decompression limit of 25 minutes. The diver should ascend to 20 fsw at 30 fsw/min, shift to air, ventilate, and then ascend directly to the surface.

Example. A diver intends to dive to 200 fsw on an 84 percent helium/16 percent oxygen mixture. The diver descends from the surface to 60 fsw at 60 fsw/min. No time is spent at 20 fsw shifting gases. At 60 fsw the diver signals for a hold and after 3 minutes at 60 fsw, the dive is aborted. The bottom time and the corrected bottom time are both 4 minutes: zero minutes at 20 fsw, 1 minute for descent, and 3 minutes at depth. The table shows a 60 fsw dive for 4 minutes is well within the no-decompression limit of 40 minutes. This diver may ascend directly to the surface at 30 fsw/min.

Example. A diver intends to dive to 300 fsw. Eight minutes is spent at 20 fsw shifting from air to an 88 percent helium/12 percent oxygen mixture. Descent is begun at 60 fsw/min but at 140 fsw the diver signals for a hold. After 2 minutes at 140 fsw the dive is aborted. The corrected bottom time is 12 minutes: 8 minutes at 20 fsw, 2 minutes of descent time from 20 fsw to 140 fsw and 2 minutes at 140 fsw. Decompression would take place on the 140-fsw/20-minute schedule.

14-3.10 Variation in Rate of Ascent. The rate of ascent to the first stop and between subsequent stops is 30 fsw/minute. Minor variations in the rate of travel between 20 and 40 fsw/minute are acceptable.

14-3.10.1 Early Arrival at the First Stop. If the divers arrive early at the first stop:

1. Begin timing the first stop when the required travel time has been completed.
2. If the first stop is 50 or 40 fsw and arrival at the stop is early, shift to oxygen and begin stop time when the required travel time has been completed.

14-3.10.2 Delays in Arriving at the First Stop.

- **Delay less than 1 minute.** Delays in arrival at the first stop of less than 1 minute may be ignored.
- **Delay in excess of 1 minute.** For delays in excess of 1 minute:
 1. Add the total delay to the bottom time.

2. Recalculate the required decompression.

- If no change in schedule is required, continue on the planned decompression.
- If a change in schedule is required and the new schedule calls for a decompression stop or stops deeper than the diver's current depth, perform any missed deeper stops at the diver's current depth. Do not go deeper.

Example. If the delay time to arrival at the first stop is 3 minutes and 25 seconds, round up to the next whole minute and add 4 minutes to the bottom time. Recheck the decompression table to see if the decompression stop depths or times have changed.

14-3.10.3 **Delays in Leaving a Stop.** Ascent time between stops is not critical as it is included in the time of the next stop.

- **Delay less than 1 minute.** When the delay is less than 1 minute, disregard the delay.
- **Delay greater than 1 minute leaving a stop deeper than 50 fsw.** Add the delay to the bottom time and recalculate the required decompression. If a new schedule is required, pick up the new schedule at the present stop. Ignore any missed stops or time deeper than the present stop.
- **Delays up to 5 minutes in leaving the 50-fsw and 40-fsw oxygen stops.** Ignore the delay. Longer delays may be associated with an increased risk of oxygen toxicity and should be avoided.

14-3.10.4 **Delays in Travel from 40 fsw to the Surface.** Disregard any delays in travel from 40 fsw to the surface during surface decompression unless the diver exceeds the 5-minute interval. When the diver exceeds the 5-minute interval, the diver shall be treated for omitted decompression (see paragraph 14-4.10).

14-3.11 **Special Procedures for Diving with an Oxygen Partial Pressure Greater Than 1.3 ata.** Limited gas supplies or system constraints may force some surface-supplied helium-oxygen dives to be performed at oxygen partial pressures greater than 1.3 ata. Such dives place the diver at increased risk for CNS oxygen toxicity on the bottom and require NAVSEA concurrence and CNO approval. Bottom times shall be limited to those shown in Table 14-4.

14-3.11.1 **Calculating Oxygen Partial Pressure.** The formula for calculating oxygen partial pressure is:

$$ppO_2 = \frac{\%O_2}{100} \times \frac{D + 33}{33}$$

Table 14-4. Oxygen Partial Pressure Exposure Limits for Surface-Supplied HeO₂ Diving.

Oxygen Partial Pressure (ata)	Maximum Bottom Time (min)
1.80	15
1.70	20
1.60	30
1.50	40
1.40	50
1.30	Unlimited

Where:

ppO₂ = Oxygen partial pressure in ata
 % O₂ = Oxygen percentage in the mixture
 D = Diver's depth in fsw

Example. A diver is at 250 fsw breathing a 17.0 percent oxygen mixture. The oxygen partial pressure is:

$$\begin{aligned} \text{ppO}_2 &= \frac{17}{100} \times \frac{250 + 33}{33} \\ &= 1.46 \text{ ata} \end{aligned}$$

To dive in accordance with this section:

1. Determine the bottom time that will be required to complete the task.
2. From Table 14-4, select the oxygen partial pressure that corresponds to this bottom time. If the bottom time is not exactly equal to the times listed in the table, round to the next longer bottom time.
3. Determine the deepest depth that will be attained by the diver during the dive.
4. Calculate the maximum oxygen percentage that can be used by rearranging the oxygen partial pressure equation to solve for the maximum oxygen percentage that can be used:

$$\% \text{O}_2 = \frac{\text{ppO}_2 \times 33}{D + 33} \times 100$$

Sample Problem. A dive to a maximum depth of 270 fsw will require 35 minutes of bottom time. Determine the maximum oxygen percentage that can be used for this dive.

1. Round the 35-minute bottom time to 40 minutes, the next longer bottom time given in Table 14-7.
2. The maximum allowable oxygen partial pressure for this bottom time is 1.50 ata.
3. Calculate the maximum oxygen percentage:

$$\begin{aligned} \% \text{O}_2 &= \frac{1.50 \times 33}{270 + 33} \times 100 \\ &= 16.34 \end{aligned}$$

14-3.11.2 **Gas Mixtures.** Any gas mixture between the calculated maximum and minimum values shown in the decompression table may be used to make the dive under the provisions of this section.

14-3.11.3 **Charting Surface-Supplied Helium-Oxygen Dives.** Figure 14-7 provides the proper format for charting surface-supplied helium-oxygen dives.

14-4 SURFACE-SUPPLIED HELIUM-OXYGEN EMERGENCY PROCEDURES

In surface-supplied mixed-gas diving, specific procedures are used in emergency situations. The following paragraphs detail these procedures. Other medical/physiological factors that surface-supplied mixed-gas divers need to consider are covered in detail in Volume 5. The U.S. Navy Treatment Tables are also presented in Volume 5.

14-4.1 **Bottom Time in Excess of the Table.** In the rare instance of diver entrapment or umbilical fouling, bottom times may exceed 120 minutes, the longest value shown in the table. When it is foreseen that bottom time will exceed 120 minutes, immediately contact the Navy Experimental Diving Unit for advice on which decompression procedure to follow. If advice cannot be obtained in time:

1. Decompress the diver using the 120-minute schedule for the deepest depth attained.
2. Surface the diver after completing 30 minutes on oxygen at 40 fsw.
3. Quickly recompress the diver to 60 fsw in the chamber.
4. Treat the diver on Treatment Table 6 (Figure 21-8).

14-4.2 **Loss of Helium-Oxygen Supply on the Bottom.** Follow this procedure if the umbilical helium-oxygen supply is lost on the bottom:

1. Shift the diver to the emergency gas system (EGS).
2. Unless the loss is momentary, abort the dive.

Date:		ppO ₂ :		Bottom Mix:					
Diver 1:		Rig:		PSIG:		O ₂ %		Left Surface:	
Diver 2:		Rig:		PSIG:		O ₂ %		Left Surface:	
Diver 3:		Rig:		PSIG:		O ₂ %		Table/Sched:	
Left Bottom:		Total Bottom Time:		Reached Surface:			Reached Surface:		
Total Decompression Time:				Total Time of Dive:					
Diving Supervisor (print):				Diving Supervisor (signature):					
Descent Rate (75 fpm max)	Emergency Decompression Table	Ascent Rate (30 fpm)	Stop Depth (fsw)	Decompression Time		Time			
				Water	Chamber	Water		Chamber	
	:68		10			L		L	
						R		R	
	:52		20			L		L	
						R		R	
	:42		30			L		L	
						R		R	
	:35		40			L		L	
						R		R	
	:30		50			L			
						R			
			60			L			
						R			
			70			L			
						R			
			80			L			
						R			
			90			L			
						R			
			100			L			
						R			
			110			L			
						R			
			120			L			
						R			
			130			L			
						R			
			140			L			
						R			
			150			L			
						R			
			160			L			
						R			
			170			L			
						R			
			180			L			
						R			
			190			L			
						R			

Figure 14-7. HeO₂ Diving Chart.

3. Remain on the EGS until arrival at the first water stop.
 - If the first water stop is an oxygen stop, shift to oxygen and complete the decompression.
 - If the first stop is a helium-oxygen stop shallower than 160 fsw, shift to air at the first stop and continue on the original decompression schedule to 50 fsw.
 - If 60 percent helium/40 percent oxygen is available, upon reaching 100-fsw shift the divers to this mixture and continue on the original decompression schedule to 50 fsw. Shift to oxygen at 50 fsw and complete the decompression.
 - If the first stop is 160 fsw or deeper, delay the air shift to 150 fsw.
4. If the EGS becomes exhausted before the first stop can be reached, shift the diver to air, ascend to the first stop and continue as outlined above.

14-4.3 Inability to Shift to 40 Percent Oxygen at 100 fsw During Decompression. If the diver cannot be shifted to 60 percent helium/40 percent oxygen at 100 fsw during decompression:

1. Shift the diver to air.
2. Follow the stops of the original decompression schedule to 50 fsw.
3. Shift to oxygen at 50 fsw and complete the decompression as originally planned.

14-4.4 Loss of Oxygen Supply at 50 fsw. In the event that the diver cannot be shifted to oxygen at 50 fsw or the oxygen supply is lost during the 50-fsw stop, take the following action. If 60 percent helium/40 percent oxygen is available on the console, shift the diver to that mixture. If 60 percent helium/40 percent oxygen is not available, shift the diver to air. If the problem can be remedied quickly, reventilate the diver with oxygen and resume the schedule at the point of interruption. Consider any time on air or helium-oxygen as dead time. If the problem cannot be remedied, keep the diver on air or helium-oxygen and use the Emergency Procedures Decompression Table (Table 14-1) to complete the decompression. Any time spent on oxygen at 50 fsw counts as decompression time on the Emergency Procedures Decompression Table.

14-4.4.1 Unable to Shift to 60/40. If it is not possible to shift the diver back to 60 percent helium/40 percent oxygen, or if the 60 percent helium/40 percent oxygen supply is also lost during the subsequent decompression, shift the diver to air and complete the dive using the Emergency Procedures Decompression Table. Any time spent on oxygen or 60 percent helium/40 percent oxygen counts toward decompression time on the Emergency Procedures Decompression Table.

- 14-4.4.2 **Surface Decompression from the Emergency Procedures Decompression Table.** The diver can be surface decompressed from the Emergency Procedures Decompression Table when the 30-fsw in-water stop is completed. Surface the diver at 30 fsw/minute and recompress in the chamber to 40 fsw. The time from leaving 30 fsw in the water to arriving at 40 fsw in the chamber cannot exceed 5 minutes. The number of oxygen breathing periods in the chamber is determined with the same method as for normal surface decompression on the original schedule.
- 14-4.5 **Loss of Oxygen Supply at the 40-fsw Stop.** If the diver cannot be shifted to oxygen at 40 fsw or the oxygen supply is lost during the 40-fsw stop, follow one of the following procedures.
- 14-4.5.1 **Oxygen Lost before Diver is within Emergency SUR D Limits.** If the loss occurs before the diver is within emergency surface decompression limits, proceed as follows:
1. If 60 percent helium/40 percent oxygen is available on the console, shift the diver to that mixture.
 2. If 60 percent helium/40 percent oxygen is not available, shift the diver to air.
 3. If the loss of oxygen can be remedied quickly, reventilate the divers with oxygen and resume the schedule at the point of interruption. Consider any time on air or helium-oxygen as dead time.
 4. If the loss of oxygen is permanent, have the divers remain on air or helium-oxygen and use the Emergency Procedures Decompression Table to complete the decompression. Time spent on oxygen at 40 fsw counts toward decompression on the Emergency Procedures Decompression Table. Surface decompression can be used after completing the 30-fsw stop.
- 14-4.5.2 **Diver is within Emergency SUR D Limits.** If the diver is within Emergency SUR D limits when the oxygen supply is lost, shift the diver to air, surface the diver, and complete decompression in accordance with Emergency SUR D procedures.
- 14-4.5.3 **Diver is within Normal SUR D Limits.** If the diver is within Normal SUR D limits when the oxygen supply is lost, shift the diver to air, surface the diver, and complete decompression in accordance with Normal SUR D procedures.
- 14-4.5.4 **Diver is in the Chamber.** If the loss occurs in the chamber, have the diver breathe chamber air.
- **Temporary Loss.** Return the diver to oxygen breathing. Consider any air time as dead time.
 - **Permanent Loss.** Follow the Emergency Procedures Decompression Table to the surface. Any time already spent on oxygen or air at 40 fsw counts toward decompression time on the Emergency Procedures Decompression Table.

14-4.6 Oxygen Supply Contaminated with Helium-Oxygen. If the oxygen supply becomes contaminated with helium-oxygen:

1. Shift the divers to helium-oxygen or air, whichever has the highest percentage of oxygen.
2. Find the contamination source and correct the problem. Probable sources of contamination include:
 - Accidental opening of the emergency gas supply (EGS) valve on the MK 21 MOD 1
 - An improper valve line-up on the console.
3. When the problem is corrected:
 - Shift the divers back to oxygen.
 - Ventilate each diver and verify voice change.
 - Ventilate each diver and listen for the gas-flow change over the communications.
 - Once a gas-flow change is heard, continue to vent for an additional 10 seconds. If a gas flow change cannot be heard, ventilate for a minimum of 20 seconds.
 - Restart the stop time. Disregard all previous time spent at the stop, i.e., treat as dead time.

14-4.7 Central Nervous System (CNS) Oxygen Toxicity Symptoms (Nonconvulsive) at the 50-fsw Stop. Follow this procedure if a diver exhibits CNS oxygen toxicity symptoms at the 50-fsw stop:

1. Bring the divers up 10 feet and shift to air to reduce the partial pressure of oxygen. Shift the console as the divers are traveling.
2. Upon reaching the 40-fsw stop, maintain communications as the buddy or standby diver monitors the stricken diver.
3. Ventilate both divers (the stricken diver first).
4. SUR D after completing the 30-fsw stop on the Emergency Procedures Decompression Table.
5. Disregard the missed time at 50 fsw.
6. If the diver convulses at 40 fsw in spite of these measures, follow the procedures outlined in paragraph 14-4.9.

- 14-4.8 CNS Oxygen Toxicity Symptoms (Nonconvulsive) at the 40-fsw Stop.**
- 14-4.8.1 **Diver is not within Emergency Surface Decompression Limits.** If symptoms appear before the diver is within emergency surface decompression limits:
1. Ascend to the 30-fsw stop and shift to air.
 2. Surface decompress after completing the 30-fsw stop on the Emergency Procedures Decompression Table.
 3. Disregard missed time at 40 fsw.
 4. If the diver convulses at 30 fsw in spite of these measures, follow the procedures outlined in paragraph 14-4.9.
- 14-4.8.2 **Diver is within Emergency Surface Decompression Limits.** If symptoms occur after the diver is within emergency surface decompression limits, surface decompress the diver using emergency SUR D procedures.
- 14-4.8.3 **Diver is within Normal Surface Decompression Limits.** If symptoms occur after the diver is within normal surface decompression limits, surface decompress the diver using normal SUR D procedures.
- 14-4.8.4 **Diver is at a Chamber Stop.** If symptoms occur during the chamber stop:
1. Remove the mask.
 2. Fifteen minutes after all symptoms have completely subsided, resume oxygen breathing at the point of interruption.
 3. Complete all required oxygen breathing time. If the diver cannot tolerate oxygen at all, complete decompression on chamber air using the stops of the Emergency Procedures Decompression Table. All previous time on oxygen and air at 40 fsw in the chamber counts toward decompression when a shift to this table is made.
- 14-4.9 CNS Oxygen Convulsion at the 50-fsw Stop or 40-fsw Stop.** If oxygen symptoms advance to convulsions, or if the diver is presumed to be convulsing at the 50-fsw stop or 40-fsw stop, a serious emergency has developed. Only general management guidelines can be presented here. Topside supervisory personnel must take whatever action they deem necessary to bring the casualty under control.
- Follow these procedures when a diver is convulsing at the 50-fsw stop or the 40-fsw stop:
1. Shift the divers to air.
 2. Have the unaffected diver ventilate himself and then ventilate the stricken diver.

3. Hold the divers at depth until the tonic-clonic phase of the sequence has subsided. The tonic-clonic phase of a convulsion generally lasts 1 to 2 minutes.
4. If only one diver is in the water, launch the standby diver immediately and have him ventilate the stricken diver.
5. If consciousness is quickly regained and voice communication reestablished, the stricken diver may be tended by the standby diver or the buddy diver and decompressed according to one of two options:
 - If the diver was eligible for emergency or normal surface decompression prior to the seizure, allow a short period for stabilization and then decompress using emergency or normal surface decompression procedures.
 - If the diver was not eligible for emergency or normal surface decompression, conduct decompression on the Emergency Procedures Decompression Table. Surface decompress upon completing the 30 fsw water stop.
6. If communication is not reestablished when the tonic-clonic phase is presumed past, but conditions are such that the standby diver or the buddy diver can verify that the affected diver is breathing and stable, conduct decompression on the Emergency Procedures Decompression Table using surface decompression upon completion of the 30 fsw water stop.
7. If it is not possible to verify that the affected diver is breathing because he cannot be reached quickly enough or visibility will not permit an assessment, the diver shall be surfaced at 40 fsw/min. In this situation, airway obstruction cannot be ruled out and to remain at depth may be fatal. As the diver has 100 percent oxygen in his lungs prior to the seizure, approximately 2 minutes may be allowed to lapse after the tonic-clonic phase ends before surfacing is initiated. Although blood carbon dioxide will be high, oxygenation should be adequate. The diver will almost certainly be unconscious and arterial gas embolism cannot be ruled out. Such a diver should receive any necessary airway support, be recompressed to 60 fsw immediately and be treated for arterial gas embolism in accordance with Figure 21-5.

14-4.10 Omitted Decompression. Certain emergencies may interrupt or prevent required decompression. Unexpected surfacing, exhausted gas supply and bodily injury are examples of such emergencies. Table 14-5 shows the initial management steps to be taken when the diver has uncontrolled ascent.

14-4.10.1 Blowup from a Depth Greater Than 50 fsw. Blowup from a depth greater than 50 fsw when more than 60 minutes of decompression is missed is an extreme emergency. The diver shall be returned as rapidly as possible to the full depth of the dive or the deepest depth of which the chamber is capable, whichever is shallower.

Table 14-5. Management of Asymptomatic Omitted Decompression.

Deepest Decompression Stop Omitted	Decompression Status	Surface Interval (Note 1)	Action	
			Nonsaturation System	Saturation System
None	No decompression stops required	N/A	Observe on surface for one hour	Observe on surface for one hour
50 fsw or shallow	Stops required. Within normal or emergency SUR D limits.	≤ 5 minutes	Follow normal or emergency SUR D procedure	Follow normal or emergency SUR D procedure
		> 5 minutes	Treatment Table 5	Treatment Table 5
	Stops required. Not within emergency SUR D limits.	≤ 5 minutes	Treatment Table 5	Treatment Table 5
		> 5 minutes	Treatment Table 6	Treatment Table 6
Deeper than 50 fsw	Stops required. <u>Less</u> than 60 minutes missed.	Any	Treatment Table 6	Treatment Table 6
	Stops required. <u>Greater</u> than 60 minutes missed.	Any	Compress to depth of dive NTE 225 fsw. Use Treatment Table 8.	Compress to depth of dive. Saturate two hours. Use saturation decompression without an initial upward excursion.

Note 1: From stop to stop.

14-4.10.2 **For Saturation Systems.** For saturation systems, initial rapid compression on air to 60 fsw, followed by compression on pure helium to the full depth of the dive (or deeper if symptom onset warrants) is indicated. The diver shall breathe 84-percent helium/16-percent oxygen by mask during the compression (if possible) to avoid the possibility of hypoxia as a result of gas pocketing in the chamber. Once at the saturation depth, the length of time spent can be dictated by the circumstances of the diver, but should not be less than 2 hours. During this 2 hours, treatment gas should be administered to the diver as outlined in Chapter 15, Chapter 15-23.8.2. The chamber oxygen partial pressure should be allowed to fall passively to 0.44-0.48 ata. Saturation decompression is begun without an upward excursion.

14-4.10.3 **For Nonsaturation Systems.** For nonsaturation systems, the diver shall be rapidly compressed on air to the depth of the dive or to 225 feet, whichever is shallower. For compressions deeper than 165 feet, remain at depth for 30 minutes. For compressions to 165 feet and shallower, remain at depth for a minimum of two hours. Decompress on USN Treatment Table 8 for Deep Blowup (Table 14-6). While deeper than 165 feet, a helium-oxygen mixture with 16-percent oxygen to 21-percent oxygen, if available, may be breathed by mask to reduce narcosis.

If the diver develops symptoms of decompression sickness or gas embolism before recompression for omitted decompression can be accomplished, immediate treatment using the appropriate oxygen or air recompression table is essential. Guidance for table selection and use is given in Chapter 21. If the depth of the

Table 14-6. U.S. Navy Treatment Table 8 for Deep Blowup.

Depth (fsw)	Max Time at Initial Treatment Depth (hours)	2-fsw Stop Times (minutes)
225	0.5	5
165	3	12
140	5	15
120	8	20
100	11	25
80	15	30
60	Unlimited	40
40	Unlimited	60
20	Unlimited	120

1. Enter the table at the depth which is exactly equal to or next greater than the deepest depth attained in the recompression. The descent rate is as fast as tolerable.
2. The maximum time that can be spent at the deepest depth is shown in the second column. The maximum time for 225 fsw is 30 minutes; for 165 fsw, three hours. For an asymptomatic diver, the minimum time at depth is 30 minutes for depths exceeding 165 fsw and two hours for depths equal to or shallower than 165 fsw.
3. Decompression is begun with a 2-fsw reduction in pressure if the depth is an even number. Decompression is begun with a 3-fsw reduction in pressure if the depth is an odd number. Subsequent stops are carried out every 2 fsw. Stop times are given in column three. The stop time begins when leaving the previous depth. Ascend to the next stop in approximately 30 seconds.
4. Stop times apply to all stops within the band up to the next quoted depth. For example, for ascent from 165 fsw, stops of 12 minutes are made at 162 fsw, and at every two-foot interval to 140 fsw. At 140 fsw, the stop time becomes 15 minutes. When traveling from 225 fsw, the 166-fsw stop is five minutes; the 164-fsw stop is 12 minutes. Once begun, decompression is continuous. For example, when decompressing from 225 feet, ascent is not halted at 165 fsw for three hours. However, ascent may be halted at 60 fsw and shallower for any desired period of time.
5. While deeper than 165 fsw, a helium-oxygen mixture with 16-21 percent oxygen may be breathed by mask to reduce narcosis. At 165 fsw and shallower, a 60-percent helium/40-percent oxygen mixture or a 60-percent nitrogen/40-percent oxygen mixture may be given to the diver as treatment gas. At 60 fsw and shallower, pure oxygen may be given to the diver as treatment gas. For all treatment gases (HeO₂, N₂O₂, and O₂), a schedule of 25 minutes on gas and five minutes on chamber air should be followed for a total of four cycles. Additional oxygen may be given at 60 fsw after a two-hour interval of chamber air. See USN Treatment Table 7 (Volume 5, Chapter 21) for guidance.
6. To avoid loss of the chamber seal, ascent may be halted at four fsw and the total remaining stop time of 240 minutes taken at this depth. Ascend directly to the surface upon completion of the required time.
7. Total ascent time from 225 fsw is 56 hours, 29 minutes. For a 165-fsw recompression, total ascent time is 53 hours 52 minutes, and for a 60-fsw recompression, 36 hours, 0 minutes.

deepest stop omitted was greater than 50 fsw and more than 60 minutes of decompression have been missed, use of Treatment Table 8 for Deep Blowup or saturation treatment is indicated. On Treatment Tables 4 and 8, a 60-percent helium/40-percent oxygen or 60-percent nitrogen/40-percent oxygen mixture may be breathed as treatment gas at 165 fsw and shallower. At 60 fsw and shallower, pure oxygen may be given to the diver as treatment gas. For all treatment gases (HeO₂, N₂O₂, and O₂) a schedule of 25 minutes on gas and 5 minutes on chamber

air should be followed for four cycles. Additional oxygen may be given at 60 fsw and shallower after a 2-hour interval of chamber air. See USN Treatment Tables 4 and 7 (Chapter 21) for guidance on additional oxygen breathing.

In all cases of deep blowup, the services of a Diving Medical Officer shall be sought at the earliest possible moment.

14-4.11 Light-Headed or Dizzy Diver on the Bottom. Dizziness is a common term used to describe a number of feelings, including light-headedness, unsteadiness, vertigo (a sense of spinning), or the feeling that one might pass out. There are a number of potential causes of dizziness in surface-supplied diving, including hypoxia, a gas supply contaminated with toxic gases such as methylchloroform, and trauma to the inner ear caused by difficult clearing of the ear. At the low levels of oxygen percentage specified for surface-supplied diving, oxygen toxicity is an unlikely cause unless the wrong gas has been supplied to the diver.

14-4.11.1 Initial Treatment. The first step to take is to have the diver stop work and ventilate the rig while topside checks the oxygen content of the supply gas. These actions should eliminate hypoxia as a cause. If ventilation does not improve symptoms, the cause may be a contaminated gas supply. Shift banks to the standby helium-oxygen supply and continue ventilation. If the condition clears, isolate the contaminated bank for future analysis and abort the dive on the standby gas supply. If the entire gas supply is suspect, place the diver on the EGS and abort the dive. Follow the guidance of paragraph 14-4.2 for ascents.

14-4.11.2 Vertigo. Vertigo due to inner ear problems will not respond to ventilation and in fact may worsen. One form of vertigo, however, alternobaric vertigo, may be so short-lived that it will disappear during ventilation. Alternobaric vertigo will usually occur just as the diver arrives on the bottom and often can be related to a difficult clearing of the ear. It would be unusual for alternobaric vertigo to occur after the diver has been on the bottom for more than a few minutes. Longer lasting vertigo due to inner ear barotrauma will not respond to ventilation and will be accompanied by an intense sensation of spinning and marked nausea. Also, it is usually accompanied by a history of difficult clearing during the descent. These characteristic symptoms may allow the diagnosis to be made. A wide variety of ordinary medical conditions may also lead to dizziness. These conditions may occur while the diver is on the bottom. If symptoms of dizziness are not cleared by ventilation and/or shifting to alternate gas supplies, have the dive partner or standby diver assist the diver(s) and abort the dive.

14-4.12 Unconscious Diver on the Bottom. An unconscious diver on the bottom constitutes a serious emergency. Only general guidance can be given here. Management decisions must be made on site, taking into account all known factors. The advice of a Diving Medical Officer shall be obtained at the earliest possible moment.

If the diver becomes unconscious on the bottom:

1. Make sure that the breathing medium is adequate and that the diver is breathing.

2. Check the status of any other divers.
3. If there is any reason to suspect gas contamination, shift to the standby helium-oxygen supply.
4. Have the dive partner or standby diver ventilate the afflicted diver to remove accumulated carbon dioxide in the helmet and ensure the correct oxygen concentration.
5. When ventilation is complete, have the dive partner or standby diver ascertain whether the diver is breathing. In the MK 21, the presence or absence of breath sounds will be audible over the intercom.
6. If the diver appears not to be breathing, the dive partner/standby diver should attempt to reposition the diver's head to open the airway. Airway obstruction will be the most common reason why an unconscious diver fails to breathe.
7. Check afflicted diver for signs of consciousness:
 - If the diver has regained consciousness, allow a short period for stabilization and then abort the dive.
 - If the diver remains unresponsive but is breathing, have the dive partner or standby diver move the afflicted diver to the stage. This action need not be rushed.
 - If the diver appears not to be breathing, make further attempts to open the airway while moving the diver rapidly to the stage.
8. Once the diver is on the stage, observe again briefly for the return of consciousness.
 - If consciousness returns, allow a period for stabilization, then begin decompression.
 - If consciousness does not return, bring the diver to the first decompression stop at a rate of 30 fsw/min (or to the surface if the diver is in a no-decompression status).
9. At the first decompression stop:
 - If consciousness returns, decompress the diver on the standard decompression schedule using normal surface decompression.
 - If the diver remains unconscious but is breathing, decompress on the standard decompression schedule and plan on emergency surface decompression from 40 fsw. If consciousness returns during ascent, use normal surface decompression.
 - If the diver remains unconscious and breathing cannot be detected in spite of repeated attempts to position the head and open the airway, an

extreme emergency exists. One must weigh the risk of catastrophic, even fatal, decompression sickness if the diver is brought to the surface, versus the risk of asphyxiation if the diver remains in the water. As a general rule, if there is any doubt about the diver's breathing status, assume he is breathing and continue normal decompression in the water. If it is absolutely certain that the diver is not breathing, leave the unaffected diver at his first decompression stop to complete decompression and surface the affected diver at 30 fsw/minute, deploying the standby diver as required. Recompress immediately and treat for omitted decompression according to Table 14-5.

- 14-4.13 Decompression Sickness in the Water.** Decompression sickness may develop in the water during surface-supplied diving. This possibility is one of the prime reasons for limiting dives to 300 fsw and allowing exceptional exposures only under emergency circumstances. The symptoms of decompression sickness may be joint pain or more serious manifestations such as numbness, loss of muscular function, or vertigo.
- 14-4.13.1 **Management.** Management of decompression sickness in the water will be difficult under the best of circumstances. Only general guidance can be presented here. Management decisions must be made on site taking into account all known factors. The advice of a Diving Medical Officer shall be obtained at the earliest possible moment.
- 14-4.13.2 **Deeper than 50 fsw.** If symptoms of decompression sickness occur deeper than 50 fsw, recompress the diver 10 fsw. Shift to a 60 percent helium/40 percent oxygen mixture if the diver is not already on that mixture. Remain at the deeper stop for 1.5 times the stop time called for in the decompression table. If no stop time is indicated in the table, use the next shallower stop time to make the calculation. If symptoms resolve or stabilize at an acceptable level, decompress the diver to the 50 fsw water stop by multiplying each intervening stop time by 1.5 or more as needed to control the symptoms. Shift to 100 percent oxygen at 50 fsw and take the standard 50-fsw stop. Ascend to 40 fsw and take a 30-minute stop on oxygen, then surface decompress and treat on Treatment Table 6. If during this scenario, symptoms worsen to the point that it is no longer practical for the diver to remain in the water, surface the diver and follow the guidelines for symptomatic omitted decompression outlined in Chapter 21 of Volume 5.
- 14-4.13.3 **At 50 fsw and Shallower.** Symptoms developing at the 50-fsw and 40-fsw oxygen breathing stops can represent either decompression sickness or oxygen toxicity. Oxygen toxicity will be a much more common occurrence. To avoid potential error in diagnosis, all symptoms with the exception of joint pain shall initially be considered oxygen toxicity and be treated accordingly. If the case is clearly decompression sickness, remain at the stop. Resolution of symptoms may occur as oxygen breathing continues.
- 14-4.13.4 **Resolution/Nonresolution.** If resolution occurs, resume the decompression, use normal surface decompression and treat on Treatment Table 6. If symptoms are

not resolved within 20 minutes at 50 fsw or within 30 minutes at 40 fsw, or have worsened to the point it is no longer practical for the diver to remain in the water, surface the diver and treat on Treatment Table 6. If symptoms originally thought to be oxygen toxicity persist or worsen following an “up ten and shift” procedure and are now felt to be decompression sickness, shift the diver to 100 percent oxygen, recompress 10 fsw and repeat the missed stop. Follow the guidance for resolution/nonresolution of symptoms as previously outlined.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table.

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)	
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50
60			BOTTOM MIX													100% O ₂		
	10	2:00															0	2:00
	20	2:00															0	2:00
	30	2:00															0	2:00
	40	2:00															0	2:00
	60	0:40															24	24:40
	80	0:40															32	32:40
	100	0:40															40	40:40
120	0:40															42	42:40	

70	10	2:20															0	2:20
	20	2:20															0	2:20
	30	2:20															0	2:20
	40	1:00															23	24:00
	60	1:00															35	36:00
	80	1:00															45	46:00
	100	1:00															50	51:00
	120	1:00															55	56:00

80	10	2:40															0	2:40
	20	2:40															0	2:40
	25	2:40															0	2:40
	30	1:20															24	25:20
	40	1:20															31	32:20
	60	1:20															47	48:20
	80	1:20															56	57:20
	100	1:20															63	64:20
120	1:20															67	68:20	

90	10	3:00															0	3:00
	20	3:00															0	3:00
	30	1:40															31	32:40
	40	1:40															39	40:40
	60	1:40															56	57:40
	80	1:40															67	68:40
	100	1:40															75	76:40
	120	1:40															78	79:40

100	10	3:20															0	3:20
	15	3:20															0	3:20
	20	2:00															25	27:00
	30	2:00															36	38:00
	40	2:00															47	49:00
	60	2:00															66	68:00
	80	2:00															77	79:00
	100	2:00															84	86:00
	120	2:00															87	89:00

* Does not include oxygen shiftover time.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)															Total Ascent Time* (min:sec)
			190	180	170	160	150	140	130	120	110	100	90	80	70	60	50	
110			BOTTOM MIX												100% O ₂			
	10	2:20															16	18:20
	20	2:20															29	31:20
	30	2:20															42	44:20
	40	2:20															53	55:20
	60	2:20															73	75:20
	80	2:20															88	88:20
	100	2:20															92	94:20
	120	2:20															96	98:20

120	10	2:40															19	21:40	
	20	2:40															34	36:40	
	30	2:40															49	51:40	
	40	2:40															62	64:40	
	60	2:40															82	84:40	
	80	2:40															94	96:40	
	100	2:40															99	101:40	
	120	2:20															10	97	109:20

130	10	2:40															10	11	23:40
	20	2:40															10	28	40:40
	30	2:40															10	45	57:40
	40	2:20												7	10	59	78:20		
	60	2:20												7	10	78	97:20		
	80	2:20												7	10	90	102:20		
	100	2:20												7	10	96	115:20		
	120	2:20												7	11	98	118:20		

140	10	3:00															10	11	24:00
	20																10	28	41:00
	30	3:00															10	45	58:00
	40													7	10	59	78:40		
	60	2:40												7	10	78	97:40		
	80													7	10	90	109:40		
	100	2:40												7	10	96	115:40		
	120													7	11	98	118:40		

150	10	3:20															10	12	25:20
	20														7	10	33	53:00	
	30	3:00													7	10	50	70:00	
	40														7	10	65	85:00	
	60	3:00													7	10	84	104:00	
	80														7	10	96	116:00	
	100	3:00													7	13	99	122:00	
	120														9	16	99	127:00	

* Does not include oxygen shiftover time.
 Exceptional Exposure times are surrounded by the black box.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)	
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50
160			BOTTOM MIX												100% O ₂			
	10	3:20													7	10	15	35:20
	20	3:20													7	10	36	56:20
	30	3:20													7	10	55	75:20
	40	3:20													7	10	70	90:20
	60	3:00												7	6	10	83	109:00
	80	3:00												7	9	10	98	127:00
	100	3:00												7	13	14	98	135:00
120	3:00												7	17	16	98	142:00	

170	10	3:20												7	0	10	17	37:20
	20	3:20												7	0	10	41	61:20
	30	3:20												7	1	10	62	83:20
	40	3:20												7	4	10	77	101:20
	60	3:20												7	10	10	92	122:20
	80	3:20												9	14	13	96	137:20
	100	3:00											7	5	18	15	99	147:20
	120	3:00											7	9	21	16	99	155:20

180	10	3:40												7	0	10	20	40:40
	20	3:40												7	0	10	44	64:40
	30	3:40												7	4	10	67	91:40
	40	3:20												7	0	8	81	109:20
	60	3:20												7	5	11	96	132:20
	80	3:20												7	9	15	99	148:20
	100	3:20												7	13	19	99	157:20
	120	3:20												7	17	23	99	165:20

190	10	4:00												7	0	10	22	43:00
	20	3:40												7	0	2	50	72:40
	30	3:40												7	0	7	69	96:40
	40	3:40												7	4	9	84	117:40
	60	3:40												7	9	13	93	137:40
	80	3:20												7	3	13	18	158:20
	100	3:20												7	6	16	21	168:20
	120	3:20												7	8	20	23	176:20

200	10	4:00												7	0	1	25	46:00
	20	4:00												7	0	4	53	78:00
	30	3:40												7	0	3	74	104:40
	40	3:40												7	0	7	86	123:40
	60	3:40												7	4	10	14	149:40
	80	3:40												7	8	14	18	165:40
	100	3:40												7	12	17	23	177:40
	120	3:40												8	15	21	23	185:40

* Does not include oxygen shiftover time.

Exceptional Exposure times are surrounded by the black box.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)		
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50	40
210			BOTTOM MIX							40% O ₂				100% O ₂					
	10	4:20										7	0	0	10	28	49:20		
	20	4:00										7	0	1	6	10	57	85:00	
	30	4:00										7	0	6	7	10	79	113:00	
	40	4:00										7	3	9	10	10	90	133:00	
	60	3:40										7	0	9	11	17	13	98	158:40
	80	3:40										7	3	11	15	20	13	99	171:40
	100	3:40										7	6	14	19	23	16	99	187:40
	120	3:40										7	8	18	23	23	16	99	197:40

220	10	4:40											7	0	2	10	30	53:40	
	20	4:20											7	0	3	7	10	61	92:20
	30	4:20											7	2	6	9	10	81	119:20
	40	4:00										7	0	6	9	11	10	93	140:00
	60	4:00										7	4	9	12	18	14	99	167:00
	80	4:00										7	8	12	17	21	16	99	184:00
	100	4:00										7	12	15	20	23	16	99	196:00
	120	4:00										8	14	19	23	23	16	99	206:00

230	10	4:40											7	0	0	3	10	33	57:40	
	20	4:20											7	0	1	4	7	10	65	98:20
	30	4:20											7	0	5	7	10	85	128:20	
	40	4:00									7	0	3	7	9	13	11	95	149:00	
	60	4:00									7	0	8	10	14	18	15	99	175:00	
	80	4:00									7	3	10	14	18	23	16	99	194:00	
	100	4:00									7	6	12	17	23	23	16	99	207:00	
	120	4:00									7	7	16	19	23	23	16	99	214:00	

240	10	4:40											7	0	0	2	4	10	35	62:40
	20												7	0	2	5	7	10	68	103:40
	30	4:20									7	0	2	6	7	10	10	87	133:20	
	40										7	0	5	8	9	14	12	96	155:20	
	60	4:20									7	4	8	11	14	19	16	99	182:20	
	80										7	7	11	16	18	23	16	99	201:20	
	100	4:20									7	10	14	19	23	23	16	99	215:20	
	120									7	3	12	17	19	23	23	16	99	223:00	

250	10	5:00											7	0	0	2	4	10	37	65:00	
	20												7	0	0	3	7	7	10	70	108:40
	30	4:40											7	0	4	6	8	10	10	89	138:40
	40												7	2	5	9	9	14	13	96	159:40
	60	4:20									7	0	7	9	12	16	21	16	99	191:20	
	80										7	3	9	13	15	21	23	16	99	210:20	
	100	4:20									7	6	11	14	19	23	23	16	99	222:20	
	120										7	8	13	19	20	23	23	16	99	232:20	

* Does not include oxygen shiftover time.
 Exceptional Exposure times are surrounded by the black box.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)		
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50	40
260	10	5:00								7	0	0	0	4	4	10	40	70:00	
	20	5:00								7	0	2	4	6	7	10	74	115:00	
	30	4:40								7	0	2	5	6	9	10	92	145:40	
	40	4:40								7	0	3	8	9	10	15	14	96	166:40
	60	4:40								7	3	7	10	14	16	21	16	99	197:40
	80	4:40								7	6	10	13	17	23	23	16	99	218:40
	100	4:20							7	2	9	13	16	20	23	23	16	99	232:20
	120	4:20							7	4	11	14	19	20	23	23	16	99	240:20

Max O₂ = 14.6%
Min O₂ = 12.0%

270	10	5:20								7	0	0	2	3	4	10	42	73:20		
	20	5:00								7	0	0	2	6	6	8	10	78	122:00	
	30	5:00								7	0	3	6	6	9	13	10	93	152:00	
	40	4:40								7	0	2	5	8	8	12	16	13	98	173:40
	60	4:40								7	0	6	8	10	14	19	23	16	99	206:40
	80	4:40								7	3	8	11	14	17	23	23	16	99	225:40
	100	4:40								7	5	11	13	16	20	23	23	16	99	237:40
	120	4:40								7	8	12	16	19	20	23	23	18	99	247:40

Max O₂ = 14.2%
Min O₂ = 12.0%

280	10	5:40								7	0	0	3	3	4	10	46	78:40			
	20	5:20								7	0	0	4	6	7	7	10	81	127:20		
	30	5:00								7	0	1	5	5	9	9	12	10	96	159:00	
	40	5:00								7	0	4	6	8	9	12	17	15	98	181:00	
	60	5:00								7	4	6	8	12	15	18	23	16	99	213:00	
	80	4:40								7	0	7	9	11	15	17	23	23	16	99	231:40
	100	4:40								7	2	9	11	15	17	20	23	23	16	99	246:40
	120	4:40								7	4	11	13	16	19	20	23	23	16	99	255:40

Max O₂ = 13.7%
Min O₂ = 12.0%

290	10	5:40								7	0	0	0	4	3	4	10	49	82:40		
	20									7	0	0	2	6	6	6	9	10	83	134:20	
	30	5:20								7	0	2	5	5	9	9	14	12	94	162:20	
	40									7	0	5	7	8	11	13	17	15	98	186:20	
	60	5:00								7	0	6	7	9	12	15	20	23	16	99	219:00
	80									7	2	8	10	12	16	19	23	23	16	99	240:00
	100	5:00								7	5	10	12	15	19	20	23	23	16	99	254:00
	120									7	8	11	16	17	19	20	23	23	16	99	264:00

Max O₂ = 13.3%
Min O₂ = 12.0%

300	10	6:00								7	0	0	0	4	3	4	10	49	83:00		
	20									7	0	0	2	6	6	6	9	10	83	134:40	
	30	5:40								7	0	2	5	5	9	9	14	12	94	162:40	
	40									7	0	5	7	8	11	13	17	15	98	186:40	
	60	5:20								7	0	6	7	9	12	15	20	23	16	99	219:20
	80									7	2	8	10	12	16	19	23	23	16	99	240:20
	100	5:20								7	5	10	12	15	19	20	23	23	16	99	254:20
	120									7	8	11	16	17	19	20	23	23	16	99	264:20

Max O₂ = 12.9%
Min O₂ = 12.0%

* Does not include oxygen shiftover time.
Exceptional Exposure times are surrounded by the black box.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)					
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50	40			
310	10	6:00						7	0	0	0	3	3	3	7	10	54	93:00				
	20	5:40					7	0	0	2	4	5	6	7	10	10	85	141:40				
	30	5:40					7	0	2	4	5	7	8	11	15	13	98	175:40				
	40	5:20					7	0	1	4	6	7	8	12	15	19	16	99	199:20			
	60	5:20					7	0	5	6	9	11	13	17	20	23	16	99	231:20			
	80	5:20					7	3	7	9	11	13	17	20	23	23	16	99	253:20			
	100	5:20					7	5	9	11	13	17	19	20	23	23	16	99	267:20			
	120	5:20					7	7	12	13	16	17	19	20	23	23	16	99	277:20			
						BOTTOM MIX					40% O ₂					100% O ₂						
320	10	6:20						7	0	0	0	4	3	3	7	10	56	96:20				
	20	6:00					7	0	0	3	5	5	6	8	10	10	88	148:00				
	30	5:40					7	0	0	4	4	6	7	9	11	17	13	98	181:40			
	40	4:40					7	0	4	4	6	7	9	12	16	20	16	99	205:40			
	60	5:20				7	0	2	6	8	9	11	14	17	23	23	16	99	240:20			
	80	5:20				7	0	6	8	8	13	14	19	20	23	23	16	99	261:20			
	100	5:20				7	2	7	10	13	16	17	19	20	23	23	16	99	277:20			
	120	5:20				7	4	9	12	13	16	17	19	20	23	23	16	99	283:20			
330	10	6:20						7	0	0	0	2	3	3	4	7	10	59	101:20			
	20	6:00					7	0	0	2	3	4	6	5	10	10	90	153:00				
	30	6:00					7	0	1	4	5	6	8	8	13	17	14	98	187:00			
	40	5:40					7	0	1	4	5	7	7	10	12	17	22	16	99	212:40		
	60	5:40					7	0	5	6	8	9	11	15	20	23	23	16	99	247:40		
	80	5:40					7	2	7	8	10	13	15	19	20	23	23	16	99	267:40		
	100	5:40					7	5	9	9	13	16	17	19	20	23	23	16	99	281:40		
	120	5:20				7	1	7	10	13	15	16	17	19	20	23	23	16	99	291:20		
340	10	6:40						7	0	0	0	3	3	3	4	7	10	61	104:40			
	20						7	0	0	2	4	5	7	8	9	10	10	90	158:20			
	30	6:00					7	0	0	3	5	5	6	8	9	13	18	14	98	192:00		
	40						7	0	2	4	6	7	8	10	13	16	22	16	99	216:00		
	60	5:40				7	0	3	5	6	9	10	13	16	18	21	23	16	99	251:40		
	80						7	0	7	7	8	11	13	15	19	20	23	23	16	99	273:40	
	100	5:40					7	2	8	8	12	13	16	17	19	20	23	23	16	99	288:40	
	120						7	4	9	11	13	15	16	17	19	20	23	23	16	99	297:40	
350	10	6:40						7	0	0	0	2	2	3	3	5	7	10	64	109:40		
	20						7	0	0	4	4	5	5	7	9	13	10	94	164:20			
	30	6:20					7	0	1	4	4	5	7	8	11	13	18	14	99	197:20		
	40						7	0	1		5	6	7	8	11	14	17	23	16	99	223:00	
	60	6:00					7	0	5	5	8	8	11	12	16	19	23	23	16	99	258:00	
	80						7	2	7		10	11	13	17	19	20	23	23	16	99	280:00	
	100	5:40					7	0	6	8	9	11	15	16	17	19	20	23	23	16	99	294:40
	120						7	1	7	9		14	15	16	17	19	20	23	23	16	99	303:40

* Does not include oxygen shiftover time.
Exceptional Exposure times are surrounded by the black box.

Table 14-7. Surface-Supplied Helium-Oxygen Decompression Table (Continued).

Depth (fsw)	Bottom Time (min.)	Time to First Stop (min:sec)	Decompression Stops (fsw)														Total Ascent Time* (min:sec)		
			190	180	170	160	150	140	130	120	110	100	90	80	70	60		50	40
			BOTTOM MIX							40% O ₂					100% O ₂				
360	10	7:00					7	0	0	0	2	2	2	3	7	7	10	66	113:00
	20	6:40				7	0	0	2	3	4	5	5	8	10	13	10	94	167:40
	30	6:20			7	0	0	3	3	5	6	7	8	11	13	19	15	99	202:20
	40	6:20			7	0	2	4	5	7	7	9	10	14	20	23	16	99	229:20
	60	6:20			7	2	5	6	7	9	11	14	16	19	23	23	16	99	263:20
	80	6:00		7	0	6	6	8	11	12	14	16	19	20	23	23	16	99	286:00
	100	6:00		7	2	7	8	11	13	13	16	17	19	20	23	23	16	99	300:00
	120	6:00		7	4	8	10	12	14	15	16	17	19	20	23	23	16	99	309:00

370	10	7:00				7	0	0	0	0	3	3	3	3	7	7	10	68	118:00	
	20	6:40			7	0	0	0	3	4	4	5	5	8	10	13	12	94	171:40	
	30	6:20		7	0	0	2	3	4	4	7	7	8	11	16	19	16	99	209:20	
	40	6:20		7	0	0	4	4	5	6	8	10	11	14	20	23	16	99	233:20	
	60	6:20		7	0	4	5	7	8	9	11	13	17	20	23	23	16	99	268:20	
	80	6:00		7	0	3	6	7	9	10	12	15	17	19	20	23	23	16	99	292:00
	100	6:00		7	0	6	7	9	10	14	15	16	17	19	20	23	23	16	99	307:00
	120	6:00		7	1	7	9	11	13	14	15	16	17	19	20	23	23	16	99	316:00

380	10	7:20				7	0	0	0	0	3	3	3	3	7	7	10	68	118:20	
	20	7:00			7	0	0	0	3	4	4	5	5	8	10	13	12	94	172:00	
	30	6:40		7	0	0	2	3	4	4	7	7	8	11	16	19	16	99	209:40	
	40	6:40		7	0	0	4	4	5	6	8	10	11	14	20	23	16	99	233:40	
	60	6:40		7	0	4	5	7	8	9	11	13	17	20	23	23	16	99	268:40	
	80	6:20		7	0	3	6	7	9	10	12	15	17	19	20	23	23	16	99	292:20
	100	6:20		7	0	6	7	9	10	14	15	16	17	19	20	23	23	16	99	307:20
	120	6:20		7	1	7	9	11	13	14	15	16	17	19	20	23	23	16	99	316:20

* Does not include oxygen shiftover time.

Exceptional Exposure times are surrounded by the black box.