

9-12 DIVING AT HIGH ALTITUDES

Because of the reduced atmospheric pressure, dives conducted at altitude require more decompression than identical dives conducted at sea level. Standard air decompression tables, therefore, cannot be used as written. Some organizations calculate specific decompression tables for use at each altitude. An alternative approach is to correct the altitude dive to obtain an equivalent sea level dive, then determine the decompression requirement using standard tables. This procedure is commonly known as the "Cross Correction" technique and always yields a sea level dive that is deeper than the actual dive at altitude. A deeper sea level equivalent dive provides the extra decompression needed to offset effects of diving at altitude.

9-12.1 Altitude Correction Procedure. To apply the "Cross Correction" technique, two corrections must be made for altitude diving. First, the actual dive depth must be corrected to determine the sea level equivalent depth. Second, the decompression stops in the sea level equivalent depth table must be corrected for use at altitude. Strictly speaking, ascent rate should also be corrected, but this third correction can safely be ignored.

9-12.1.1 Correction of Depth of Dive. Depth of a sea level equivalent dive is determined by multiplying the depth of the dive at altitude by a ratio of atmospheric pressure at sea level to atmospheric pressure at altitude. Using millibars (mb) as a unit for expressing atmospheric pressure at altitude equivalent depth is then:

$$\text{Equivalent Depth (fsw)} = \text{Altitude Depth (fsw)} \times \frac{\text{Pressure at Sea Level (mb)}}{\text{Pressure at Altitude (mb)}}$$

Example: A diver makes a dive to 60 fsw at an altitude of 5000 ft. The atmospheric pressure measured at 5000 ft is 843 millibars (0.832 ATA). Atmospheric pressure at sea level is assumed to be 1013 millibars (1.000 ATA). Sea level equivalent depth is then:

$$\text{Equivalent Depth (fsw)} = 60 \text{ fsw} \times \frac{1013 \text{ mb}}{843 \text{ mb}} = 72.1 \text{ fsw}$$

9-12.1.2 Correction for Decompression Stop Depths. Depth of the corrected stop at altitude is calculated by multiplying depth of a sea level equivalent stop by a ratio of atmospheric pressure at altitude to atmospheric pressure at sea level. [Note: this ratio is inverse to the ratio in the formula above.]

$$\text{Altitude Stop Depth (fsw)} = \text{Sea Level Stop Depth (fsw)} \times \frac{\text{Pressure at Altitude (mb)}}{\text{Pressure at Sea Level (mb)}}$$

Example: A diver makes a dive at an altitude of 5000 ft. An equivalent sea level dive requires a decompression stop at 20 fsw. Stop depth used at altitude is then:

$$\text{Altitude Stop Depth (fsw)} = 20 \text{ fsw} \times \frac{843 \text{ mb}}{1013 \text{ mb}} = 16.6 \text{ fsw}$$

To simplify calculations, Table 9-3 gives corrected sea level equivalent depths and equivalent stops depths for dives from 10-190 ft and for altitudes from 1,000 to 10,000 ft in 1000 ft increments.

WARNING Table 9-3 cannot be used with constant ppO₂ diving equipment, such as the MK 16.

9-12.2 **Need for Correction.** No correction is required for dives conducted at altitudes between sea level and 300 ft. The additional risk associated with these dives is minimal. At altitudes between 300 and 1000 feet, correction is required for dives deeper than 145 fsw (actual depth). At altitudes above 1000 ft., correction is required for all dives.

9-12.3 **Depth Measurement at Altitude.** The preferred method for measuring depth at altitude is a mechanical or electronic gauge that can be re-zeroed at the dive site. Once re-zeroed, no further correction of the reading is required.

When using a recompression chamber for decompression, zero the chamber depth gauges before conducting surface decompression.

Most mechanical depth gauges carried by divers have a sealed one atmosphere reference and cannot be adjusted for altitude, thus they will read low throughout a dive at altitude. A correction factor of 1 fsw for every 1000 ft of altitude should be added to the reading of a sealed reference gauge before entering Table 9-3.

Pneumofathometers can be used at altitude. Add the pneumofathometer correction factor (Table 9-1) to the depth reading before entering Table 9-3. The pneumofathometer correction factors are unchanged at altitude.

A sounding line or fathometer may be used to measure the depth if a suitable depth gauge is not available. These devices measure the linear distance below the surface of the water, not the water pressure. Though fresh water is less dense than sea water, all dives will be assumed to be conducted in sea water, thus no corrections will be made based on water salinity. Enter Table 9-3 directly with the depth indicated on the line or fathometer.

9-12.4 **Equilibration at Altitude.** Upon ascent to altitude, two things happen. The body off-gases excess nitrogen to come into equilibrium with the lower partial pressure of nitrogen in the atmosphere. It also begins a series of complicated adjustments to the lower partial pressure of oxygen. The first process is called equilibration; the second is called acclimatization. Twelve hours at altitude is required for equilibration. A longer period is required for full acclimatization.

Table 9-3. Sea Level Equivalent Depth (fsw).

Actual Depth (fsw)	Altitude (feet)									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
10	10	15	15	15	15	15	15	15	15	15
15	15	20	20	20	20	20	20	25	25	25
20	20	25	25	25	25	25	30	30	30	30
25	25	30	30	30	35	35	35	35	35	40
30	30	35	35	35	40	40	40	50	50	50
35	35	40	40	50	50	50	50	50	50	60
40	40	50	50	50	50	50	60	60	60	60
45	45	50	60	60	60	60	60	70	70	70
50	50	60	60	60	70	70	70	70	70	80
55	55	60	70	70	70	70	80	80	80	80
60	60	70	70	70	80	80	80	90	90	90
65	65	70	80	80	80	90	90	90	100	100
70	70	80	80	90	90	90	100	100	100	110
75	75	90	90	90	100	100	100	110	110	110
80	80	90	90	100	100	100	110	110	120	120
85	85	100	100	100	110	110	120	120	120	130
90	90	100	110	110	110	120	120	130	130	140
95	95	110	110	110	120	120	130	130	140	140
100	100	110	120	120	130	130	130	140	140	150
105	105	120	120	130	130	140	140	150	150	160
110	110	120	130	130	140	140	150	150	160	160
115	115	130	130	140	140	150	150	160	170	170
120	120	130	140	140	150	150	160	170	170	180
125	125	140	140	150	160	160	170	170	180	190
130	130	140	150	160	160	170	170	180	190	190
135	135	150	160	160	170	170	180	190	190	200
140	140	160	160	170	170	180	190	190	200	210
145	145	160	170	170	180	190	190	200	210	
150	160	170	170	180	190	190	200	210		
155	170	170	180	180	190	200	210			
160	170	180	180	190	200	200				
165	180	180	190	200	200					
170	180	190	190	200						
175	190	190	200							
180	190	200	210							
185	200	200								
190	200									
Table Water	Equivalent Stop Depths (fsw)									
10	10	9	9	9	8	8	8	7	7	7
20	19	19	18	17	17	16	15	15	14	14
30	29	28	27	26	25	24	23	22	21	21
40	39	37	36	35	33	32	31	30	29	28
50	48	47	45	43	42	40	39	37	36	34
60	58	56	54	52	50	48	46	45	43	41

Note: = Exceptional Exposure Limit

If a diver begins a dive at altitude within 12 hours of arrival, the residual nitrogen left over from sea level must be taken into account. In effect, the initial dive at altitude can be considered a repetitive dive, with the first dive being the ascent from sea level to altitude. Table 9-4 gives the repetitive group associated with an initial ascent to altitude. Using this group and the time at altitude before diving, enter the Residual Nitrogen Timetable for Repetitive Air Dives (Table 9-7) to determine a new repetitive group designator associated with that period of equilibration. Determine sea level equivalent depth for your planned dive using Table 9-3. From your new repetitive group and sea level equivalent depth, determine the residual nitrogen time associated with the dive. Add this time to the actual bottom time of the dive.

Example: A diver ascends rapidly to 6000 feet in a helicopter and begins a dive to 100 fsw 90 minutes later. How much residual nitrogen time should be added to the dive?

From Table 9-4, repetitive group upon arrival at 6000 feet is Group E. During 90 minutes at altitude, the diver will desaturate to Group D. From Table 9-3, sea level equivalent depth for a 100 fsw dive is 130 fsw. From Table 9-7, residual nitrogen time for a 130 fsw dive in Group D is 11 minutes. The diver should add 11 minutes to bottom time.

Table 9-4 can also be used when a diver who is fully equilibrated at one altitude ascends to and dives at a higher altitude. Enter Table 9-4 with the difference between the two altitudes to determine an initial repetitive group.

Example: Divers equilibrated at a base camp altitude of 6000 feet, fly by helicopter to the dive site at 10,000 feet. The difference between the altitudes is 4000 feet. From Table 9-4, the initial repetitive group to be used at 10,000 feet is Group C.

WARNING Altitudes above 10,000 feet can impose serious stress on the body resulting in significant medical problems while the acclimatization process takes place. Ascents to these altitudes must be slow to allow acclimatization to occur and prophylactic drugs may be required. These exposures should always be planned in consultation with a Diving Medical Officer. Commands conducting diving operations above 10,000 feet may obtain the appropriate decompression procedures from NAVSEA 00C.

9-12.5 Diving At Altitude Worksheet. Figure 9-22 is a worksheet for altitude diving. To determine Sea Level Equivalent Depth (SLED) and corrected decompression stops for an altitude dive, follow these steps:

9-12.5.1 Corrections for Depth of Dive at Altitude and In-Water Stops.

Line 1. Determine dive site altitude by referring to a map. From Table 9-3, enter the altitude in feet that is equal to, or next greater than the altitude at the dive site.

Line 2. Enter the actual depth of the dive in feet of seawater.

Table 9-4. Repetitive Groups Associated with Initial Ascent to Altitude.

Altitude (feet)	Repetitive Group
1000	A
2000	B
3000	B
4000	C
5000	D
6000	E
7000	E
8000	F
9000	G
10000	H

NOTE Refer to paragraph 9-12.3 to correct divers' depth guage readings to actual depths at altitude.

Line 3. Read Table 9-3 vertically down the Actual Depth column. Select a depth that is equal to or next greater than the actual depth. Reading horizontally, select the Sea Level Equivalent Depth corresponding to an altitude equal or next greater than that of your dive site.

9-12.5.2 **Corrections for Equilibration.**

Line 4. Enter the Repetitive Group upon arrival at altitude from Table 9-4 for the altitude listed on Line 1.

Line 5. Record time in hours and minutes spent equilibrating at altitude prior to the dive. If time at altitude is greater than 12 hours, proceed to step 7 and enter zero.

Line 6. Using Table 9-7, determine the Repetitive Group at the end of the pre-dive equilibration interval.

Line 7. Using Table 9-7, determine the Residual Nitrogen Time for the new repetitive group designation from line 6 and the Sea Level Equivalent Depth from line 3.

Line 8. Enter the planned bottom time.

Line 9. Add the bottom time and the residual nitrogen time to obtain the equivalent Single Dive Time.

Line 10. Select the Decompression Table to be used.

Line 11. Enter the Schedule from the Decompression Table using the Sea Level Equivalent Depth from line 3 and equivalent Single Dive Time from line 9.

DIVING AT ALTITUDE WORKSHEET

DATE _____

Actual Dive Site Altitude _____ feet

1. Altitude from Table 9-3. _____ feet

2. Actual Depth of Dive (corrected per section 9-12.3) _____ fsw

3. Sea Level Equivalent Depth from Table 9-3 _____ SLED

4. Repetitive Group from Table 9-4 _____

5. Time at Altitude _____ hrs _____ min

6. New Repetitive Group Designation from Table 9-7 _____

7. Residual Nitrogen Time _____ min

8. Planned Bottom Time + _____ min

9. Equivalent Single Dive Time = _____ min

10. Decompression Table

- Standard Air Table
- Unlimited/No-Decompression Table
- Surface Table Using Oxygen
- Surface Table Using Air

11. Table/Schedule _____ / _____

12. Decompression Schedule

Sea Level Stop Depth	Altitude Stop Depth	Stop Time (Water/Chamber)
10 fsw	_____ fsw	____ / ____ min
20 fsw	_____ fsw	____ / ____ min
30 fsw	_____ fsw	____ / ____ min
40 fsw	_____ fsw	____ / ____ min*
50 fsw	_____ fsw	_____ min
60 fsw	_____ fsw	_____ min

13. Repetitive Group Letter Designation _____ *Chamber stop on SUR D O₂ will be at 40 fsw.

Figure 9-22. Worksheet for Diving at Altitude.

Line 12. Using the lower section of Table 9-3, read down the Table Water Stops column on the left to the decompression stop(s) given in the Sea Level Equivalent Depth Table/Schedule. Read horizontally to the altitude column. Record the corresponding altitude stop depths on the worksheet.

NOTE For surface decompression dives on oxygen, the chamber stops are not adjusted for altitude. Enter the same depths as at sea level. Keeping chamber stop depths the same as sea level provides an extra decompression benefit for the diver on oxygen. For surface decompression on air, stops must be adjusted. (See the example below and Figure 9-23.)

Line 13. Record the Repetitive Group Designator at the end of the dive.

NOTE Follow all decompression table procedures for ascent and descent

Example: Five hours after arriving at an altitude of 7750 feet, divers make a 60 min air dive to a gauge depth of 75 fsw. Depth is measured with a pneumofathometer having a non-adjustable gauge with a fixed reference pressure of one atmosphere. The Surface Decompression Table Using Oxygen will be used for decompression. What is the proper decompression schedule?

The altitude is first rounded up to 8000 feet. A depth correction of +8 fsw must be added to the maximum depth recorded on the fixed reference gauge. A pneumofathometer correction factor of + 1 fsw must also be added. The divers' actual depth is 84 fsw. Table 9-3 is entered at an actual depth of 85 fsw. The Sea Level Equivalent Depth for 8000 feet of altitude is 120 fsw. The repetitive group upon arrival at altitude is Group F. This decays to Group B during the five hours at altitude pre-dive. The residual nitrogen time for Group B at 120 fsw is 6 minutes. The Equivalent Single Dive Time therefore is 66 minutes. The appropriate decompression schedule from the Surface Decompression Table Using Oxygen is 120 fsw for 70 minutes. By the schedule, a 4-minute stop at 30 fsw in the water and a 39-minute stop at 40 fsw in the chamber are required. The water stop is taken at a depth of 22 fsw. The chamber stop is taken at a depth of 40 fsw.

Figure 9-23 shows the filled-out Diving at Altitude Worksheet for this dive. Figure 9-24 shows the filled-out Diving Chart.

9-12.6 Repetitive Dives. Repetitive dives may be conducted at altitude. The procedure is identical to that at sea level, with the exception that the sea level equivalent dive depth is always used to replace the actual dive depth. Figure 9-25 (on page 9-48) is a Repetitive Dive at Altitude Worksheet.

Example: Fourteen hours after ascending to an altitude of 7750 feet, divers make a 82 fsw 60 min MK 21 dive using the Standard Air Table. Depth is measured with a pneumofathometer having a depth gauge adjustable for altitude. After two hours and 10 min on the surface, they make a second dive to 79 fsw for 30 min and decompress on the Surface Decompression Table Using Oxygen. What is the proper decompression schedule for the second dive?

The altitude is first rounded up to 8000 feet. For the first dive, a depth correction of +1 fsw must be added to the 82 fsw pneumofathometer reading. The divers

DIVING AT ALTITUDE WORKSHEET

DATE 10 Jan 99

Actual Dive Site Altitude 7,750 feet

1. Altitude from Table 9-3. 8,000 feet

2. Actual Depth of Dive (corrected per section 9-12.3) 75 + 8 + 1 = 84 fsw

3. Sea Level Equivalent Depth from Table 9-3 120 SLED

4. Repetitive Group from Table 9-4 F

5. Time at Altitude 5 hrs — min

6. New Repetitive Group Designation from Table 9-7 B

7. Residual Nitrogen Time 6 min

8. Planned Bottom Time + 60 min

9. Equivalent Single Dive Time = 66 min

10. Decompression Table

Standard Air Table

Unlimited/No-Decompression Table

Sur D Table Using Oxygen

Sur D Table Using Air

11. Table/Schedule 120 / 70

12. Decompression Schedule

Sea Level Stop Depth	Altitude Stop Depth	Stop Time (Water/Chamber)
10 fsw	_____ fsw	<u>/</u> min
20 fsw	_____ fsw	<u>/</u> min
30 fsw	<u>22</u> fsw	<u>4 /</u> min
40 fsw	_____ fsw	<u>/39</u> min*
50 fsw	_____ fsw	_____ min
60 fsw	_____ fsw	_____ min

13. Repetitive Group Letter Designation _____ *Chamber stop on SUR D O₂ will be at 40 fsw.

Figure 9-23. Completed Worksheet for Diving at Altitude

DIVING CHART - AIR

1056

ALTITUDE 8000

Date 10 Jan 99

NAME OF DIVER 1 <i>ENCS Payne</i>		DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2900</i>
NAME OF DIVER 2 <i>BMC Wilson</i>		DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2900</i>
TENDERS (DIVER 1) <i>SW1 Merkes AND CDR Southerland</i>			TENDERS (DIVER 2) <i>SW1 Norris AND CE1 Menzie</i>	
LEFT SURFACE (LS) <i>0900</i>	DEPTH (fsw) <i>75+8+1=84 / SLED / 120</i>	REACHED BOTTOM (RB) <i>0901</i>	DESCENT TIME <i>:01</i>	
LEFT BOTTOM (LB) <i>1000</i>	TOTAL BOTTOM TIME (TBT) <i>RNT</i> <i>(:60+ :06 = :66)</i>	TABLE & SCHEDULE USED <i>120/:70 Sur 'D' O</i>	TIME TO FIRST STOP <i>1::46</i>	
REACHED SURFACE (RS) <i>1006::30 / 1055::50</i>	TOTAL DECOMPRESSION TIME (TDT) <i>55::50</i>	TOTAL TIME OF DIVE (TTD) <i>01:55::50</i>	REPETITIVE GROUP <i>N/A</i>	

DESCENT	ASCENT	DEPTH OF STOPS	DECOMPRESSION TIME		TIME	
			WATER	CHAMBER	WATER	CHAMBER
	<i>:44</i>	10			L	
	<i>:30</i>	20			R	
	<i>:30</i>	22	<i>:04</i>		L <i>1005::46</i>	
	<i>:30</i>	30			R <i>1001::46</i>	
<i>7</i>	<i>1::46</i>	40		<i>:30 O</i> <i>:05 Air</i> <i>:09 O</i>	L	<i>1054::30</i>
<i>5</i>	<i>3</i>				R	<i>1010::30</i>
	<i>0</i>	50			L	
<i>f</i>	<i>f</i>	60			R	
<i>p</i>	<i>p</i>	70			L	
<i>m</i>	<i>m</i>	75			R	
<i>:01</i>		80			L <i>1000</i>	
					R <i>0901</i>	
		90			L	
					R	
		100			L	
					R	
		110			L	
					R	
		120			L	
					R	
		130			L	
					R	

PURPOSE OF DIVE <i>Search</i>	REMARKS <i>Sur 'D' O, OK to Repet</i>
DIVER'S CONDITION <i>OK</i>	DIVING SUPERVISOR <i>BUCS (MDV) Daniels</i>

Figure 9-24. Completed Chart for Dive at Altitude.

REPETITIVE DIVE AT ALTITUDE WORKSHEET

DATE

1. PREVIOUS DIVE

_____ minutes Standard Air Table Unlimited/No-Decompression Table
 _____ SLED Sur D Table Using Oxygen Sur D Table Using Air
 _____ repetitive group letter designation

2. SURFACE INTERVAL

_____ hours _____ minutes on surface
 _____ repetitive group from Item 1 above
 _____ new repetitive group letter designation from Residual Nitrogen Timetable

3. RESIDUAL NITROGEN TIME FOR REPETITIVE DIVE

Altitude from Table 9-3 _____ feet
 Actual Depth of Dive (corrected per section 9-12.3) _____ fsw
 Sea Level Equivalent Depth of repetitive dive from Table 9-3 _____ SLED
 _____ new repetitive group letter designation from item 2 above
 _____ minutes, residual nitrogen time from Residual Nitrogen Timetable or
 bottom time of previous Sur D dive

4. EQUIVALENT SINGLE DIVE TIME:

_____ minutes, residual nitrogen time from item 3 above or bottom time of previous Sur D dive
 + _____ minutes, actual bottom time of repetitive dive
 = _____ minutes, equivalent single dive time

5. DECOMPRESSION FOR REPETITIVE DIVE:

_____ SLED of repetitive dive
 _____ minutes, equivalent single dive time from item 4 above

Decompression from (check one):

Standard Air Table Unlimited/No-Decompression Table
 Sur D Table Using Oxygen Sur D Table Using Air

_____ schedule used (depth/time)

Sea Level Stop Depth:	Altitude Stop Depth	Water Stop Time	Chamber Stop Time
10 fsw	_____ fsw	_____ minutes	_____ minutes
20 fsw	_____ fsw	_____ minutes	_____ minutes
30 fsw	_____ fsw	_____ minutes	_____ minutes
40 fsw	_____ fsw	_____ minutes	_____ minutes*
50 fsw	_____ fsw	_____ minutes	_____ minutes
60 fsw	_____ fsw	_____ minutes	_____ minutes

_____ repetitive group letter designation

*Chamber stop on SUR D O₂ will be at 40 fsw.

Figure 9-25. Worksheet for Repetitive Dive at Altitude.

actual depth on the first dive is 83 fsw. Table 9-3 is entered at an actual depth of 85 fsw. The Sea Level Equivalent Depth for the first dive is 120 fsw. The repetitive group designation upon completion of the 60 min dive is Group O. This decays to Group H during the 2 hour 10 min surface interval.

The actual depth of the second dive is 80 fsw (79 fsw plus a 1 fsw pneumofathometer correction). Table 9-3 is entered at an actual depth of 80 fsw. The Sea Level Equivalent Depth for the second dive is 110 fsw. The residual nitrogen time for Group H at 110 fsw is 27 min. The equivalent single dive time therefore is 57 min. The appropriate decompression schedule from the Surface Decompression Table Using Oxygen is 110 fsw for 60 min. A 26 min stop at 40 fsw in the chamber is required by the schedule. This stop is taken at a chamber depth of 40 fsw.

Figure 9-26 shows the filled-out Repetitive Dive at Altitude Worksheet for these two dives. Figure 9-27 and Figure 9-28 shows the filled out Diving Charts for the first and second dives.

9-13 ASCENT TO ALTITUDE AFTER DIVING/FLYING AFTER DIVING.

Leaving the dive site may require temporary ascent to a higher altitude. For example, divers may drive over a mountain pass at higher altitude or leave the dive site by air. Ascent to altitude after diving increases the risk of decompression sickness because of the additional reduction in atmospheric pressure. The higher the altitude, the greater the risk. (Pressurized commercial airline flights are addressed in Note 3 of Table 9-5.)

Table 9-5 gives the surface interval (hours:minutes) required before making a further ascent to altitude. The surface interval depends on the planned increase in altitude and the highest repetitive group designator obtained in the previous 24-hour period. Enter the table with the highest repetitive group designator obtained in the previous 24-hour period. Read the required surface interval from the column for the planned change in altitude.

Example: A diver surfaces from a 60 fsw for 60 minutes no-decompression dive at sea level in Repetitive Group J. After a surface interval of 6 hours 10 minutes, the diver makes a second dive to 30 fsw for 20 minutes placing him in Repetitive Group C. He plans to fly home in a commercial aircraft in which the cabin pressure is controlled at 8000 feet. What is the required surface interval before flying?

The planned increase in altitude is 8000 feet. Because the diver has made two dives in the previous 24-hour period, you must use the highest Repetitive Group Designator of the two dives. Enter Table 9-5 at 8000 feet and read down to Repetitive Group J. The diver must wait 17 hours and 35 minutes after completion of the second dive before flying.

Example: Upon completion of a dive at an altitude of 4000 feet, the diver plans to ascend to 7500 feet in order to cross a mountain pass. The diver's repetitive group upon surfacing is Group G. What is the required surface interval before crossing the pass?

REPETITIVE DIVE AT ALTITUDE WORKSHEET

DATE 10 Jan 99

1. PREVIOUS DIVE

:60 minutes Standard Air Table Unlimited/No-Decompression Table
120 SLED Surface Table Using Oxygen Surface Table Using Air
0 repetitive group letter designation

2. SURFACE INTERVAL

2 hours 10 minutes on surface
0 repetitive group from Item 1 above
H new repetitive group letter designation from Residual Nitrogen Timetable

3. RESIDUAL NITROGEN TIME FOR REPETITIVE DIVE

Altitude from Table 9-3 8000 feet
 Actual Depth of Dive (corrected per section 9-12.3) 79+1=80 fsw
 Sea Level Equivalent Depth of repetitive dive from Table 9-3 110 SLED
H new repetitive group letter designation from item 2 above
:27 minutes, residual nitrogen time from Residual Nitrogen Timetable or bottom time of previous Sur D dive

4. EQUIVALENT SINGLE DIVE TIME:

:27 minutes, residual nitrogen time from item 3 above or bottom time of previous Sur D dive
 + :30 minutes, actual bottom time of repetitive dive
 = :57 minutes, equivalent single dive time

5. DECOMPRESSION FOR REPETITIVE DIVE:

110 SLED of repetitive dive
:57 minutes, equivalent single dive time from item 4 above

Decompression from (check one):

Standard Air Table Unlimited/No-Decompression Table
 Sur D Table Using Oxygen Sur D Table Using Air

110/60 schedule used (depth/time)

Sea Level Stop Depth:	Altitude Stop Depth	Water Stop Time	Chamber Stop Time
10 fsw	_____ fsw	_____ minutes	_____ minutes
20 fsw	_____ fsw	_____ minutes	_____ minutes
30 fsw	_____ fsw	_____ minutes	_____ minutes
40 fsw	_____ fsw	_____ minutes	<u>26</u> minutes*
50 fsw	_____ fsw	_____ minutes	_____ minutes
60 fsw	_____ fsw	_____ minutes	_____ minutes

N/A repetitive group letter designation

*Chamber stop on SUR D O, will be at 40 fsw.

Figure 9-26. Completed Worksheet for Repetitive Dive at Altitude.

DIVING CHART - AIR

1112

ALTITUDE 8000

Date 10 Jan 99

NAME OF DIVER 1 <i>ENCS Payne</i>		DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2900</i>
NAME OF DIVER 2 <i>BMC Wilson</i>		DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2900</i>
TENDERS (DIVER 1) <i>CDR Morrison AND BMC Carpenter</i>			TENDERS (DIVER 2) <i>BM2 Telitz AND AO1 Beatty</i>	
LEFT SURFACE (LS) <i>0900</i>	DEPTH (fsw) <i>82+1=83 SLED 120</i>	REACHED BOTTOM (RB) <i>0902</i>	DESCENT TIME <i>:02</i>	
LEFT BOTTOM (LB) <i>1000</i>	TOTAL BOTTOM TIME (TBT) <i>:60</i>	TABLE & SCHEDULE USED <i>120/60 Std Air</i>	TIME TO FIRST STOP <i>:02</i>	
REACHED SURFACE (RS) <i>1111::44</i>	TOTAL DECOMPRESSION TIME (TDT) <i>1:11::44</i>	TOTAL TIME OF DIVE (TTD) <i>2:11::44</i>	REPETITIVE GROUP <i>0</i>	

DESCENT	ASCENT	DEPTH OF STOPS	DECOMPRESSION TIME		TIME	
			WATER	CHAMBER	WATER	CHAMBER
	<i>:14</i>	<i>7</i> <i>10</i>	<i>:45</i>		L <i>1111::30</i>	
					R <i>1026::30</i>	
	<i>:16</i>	<i>15</i> <i>20</i>	<i>:22</i>		L <i>1026::14</i>	
					R <i>1004::14</i>	
	<i>:14</i>	<i>22</i> <i>30</i>	<i>:02</i>		L <i>1004</i>	
					R <i>1002</i>	
	<i>:02</i>	<i>40</i>			L	
					R	
<i>7</i>	<i>3</i>				L	
<i>5</i>	<i>0</i>	<i>50</i>			R	
					L	
<i>f</i>	<i>f</i>	<i>60</i>			R	
<i>p</i>	<i>p</i>	<i>70</i>			L	
<i>m</i>	<i>m</i>				R	
		<i>80</i>			L	
					R	
<i>:02</i>		<i>82</i> <i>90</i>			L <i>1000</i>	
					R <i>0902</i>	
		<i>100</i>			L	
					R	
		<i>110</i>			L	
					R	
		<i>120</i>			L	
					R	
		<i>130</i>			L	
					R	

PURPOSE OF DIVE <i>Search</i>	REMARKS <i>Std Air OK to Repet</i>
DIVER'S CONDITION <i>OK</i>	DIVING SUPERVISOR <i>HTCM (MDV) Phalin</i>

Figure 9-27. Completed Chart for Dive at Altitude.

DIVING CHART - AIR

1426

ALTITUDE 8000

Date 10 Jan 99

NAME OF DIVER 1 <i>ENCS Payne</i>	DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2825</i>
NAME OF DIVER 2 <i>BMC Wilson</i>	DIVING APPARATUS <i>MK 21</i>	TYPE DRESS <i>Wet Suit</i>	EGS (PSIG) <i>2825</i>
TENDERS (DIVER 1) <i>BU1 Doyle</i> AND <i>UT2 Stacy</i>		TENDERS (DIVER 2) <i>SW2 Brooks</i> AND <i>BU2 McElroy</i>	
LEFT SURFACE (LS) <i>1322</i>	DEPTH (fsw) <i>79+1=80 / 110</i>	REACHED BOTTOM (RB) <i>1324</i>	DESCENT TIME <i>:02</i>
LEFT BOTTOM (LB) <i>1352</i>	TOTAL BOTTOM TIME (TBT) RNT <i>:30+ :27 = :57</i>	TABLE & SCHEDULE USED <i>110/60 Sur 'D' O.</i>	TIME TO FIRST STOP <i>:02::38</i>
REACHED SURFACE (RS) <i>1354::38/1425::58</i>	TOTAL DECOMPRESSION TIME (TDT) <i>:33::58</i>	TOTAL TIME OF DIVE (TTD) <i>1:03:58</i>	REPETITIVE GROUP <i>N/A</i>

DESCENT	ASCENT	DEPTH OF STOPS	DECOMPRESSION TIME		TIME	
			WATER	CHAMBER	WATER	CHAMBER
		10			L	
		20			R	
		30			L	
		40			R	
		40		<i>:26</i>	L	<i>1424::38</i>
<i>7</i>	<i>3</i>	40			R	<i>1358::38</i>
<i>5</i>	<i>0</i>	50			L	
		50			R	
<i>f</i>	<i>f</i>	60			L	
<i>p</i>	<i>p</i>	60			R	
<i>m</i>	<i>m</i>	70			L	
<i>m</i>	<i>m</i>	70			R	
<i>.02</i>		<i>79</i>			L	<i>1352</i>
		<i>80</i>			R	<i>1324</i>
		90			L	
		90			R	
		100			L	
		100			R	
		110			L	
		110			R	
		120			L	
		120			R	
		130			L	
		130			R	

PURPOSE OF DIVE <i>Search</i>	REMARKS <i>Sur 'D' O, OK to Repet</i>
DIVER'S CONDITION <i>OK</i>	DIVING SUPERVISOR <i>MDV Deen</i>

Figure 9-28. Completed Chart for Repetitive Dive at Altitude.

Table 9-5. Required Surface Interval Before Ascent to Altitude After Diving.

Repetitive Group Designator	Increase in Altitude									
	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
A	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
B	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
C	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:00
D	0:00	0:00	0:00	0:00	0:00	0:00	0:00	0:09	3:28	7:33
E	0:00	0:00	0:00	0:00	0:00	0:51	3:35	6:54	10:59	16:18
F	0:00	0:00	0:00	0:00	1:12	3:40	6:23	9:43	13:47	19:07
G	0:00	0:00	0:00	1:23	3:34	6:02	8:46	12:05	16:10	21:29
H	0:00	0:00	1:31	3:26	5:37	8:05	10:49	14:09	18:13	23:33
I	0:00	1:32	3:20	5:15	7:26	9:54	12:38	15:58	20:02	24:00
J	1:32	3:09	4:57	6:52	9:04	11:32	14:16	17:35	21:39	24:00
K	3:00	4:37	6:25	8:20	10:32	13:00	15:44	19:03	23:07	24:00
L	4:21	5:57	7:46	9:41	11:52	14:20	17:04	20:23	24:00	24:00
M	5:35	7:11	9:00	10:55	13:06	15:34	18:18	21:37	24:00	24:00
N	6:43	8:20	10:08	12:03	14:14	16:42	19:26	22:46	24:00	24:00
O	7:47	9:24	11:12	13:07	15:18	17:46	20:30	23:49	24:00	24:00
Z	8:17	9:54	11:42	13:37	15:49	18:17	21:01	24:00	24:00	24:00

Exceptional Exposure

Wait 48 hours before flying

NOTE 1 When using Table 9-5, use the highest repetitive group designator obtained in the previous 24-hour period.

NOTE 2 Table 9-5 may only be used when the maximum altitude achieved is 10,000 feet or less. For ascents above 10,000 feet, consult NAVSEA 00C for guidance.

NOTE 3 The cabin pressure in commercial aircraft is maintained at a constant value regardless of the actual altitude of the flight. Though cabin pressure varies somewhat with aircraft type, the nominal value is 8,000 feet. For commercial flights, use a final altitude of 8000 feet to compute the required surface interval before flying.

NOTE 4 No surface interval is required before taking a commercial flight if the dive site is at 8000 feet or higher. In this case, flying results in an increase in atmospheric pressure rather than a decrease.

NOTE 5 No repetitive group is given for air dives with surface decompression on oxygen or air. For these surface decompression dives, enter the standard air table with the sea level equivalent depth and bottom time of the dive to obtain the appropriate repetitive group designator to be used.

NOTE 6 For ascent to altitude following a non-saturation helium-oxygen dive, wait 12 hours if the dive was a no-decompression dive. Wait 24 hours if the dive was a decompression dive.

The planned increase in altitude is 3500 feet. Enter Table 9-5 at 4000 feet and read down to Repetitive Group G. The diver must delay 1 hour and 23 minutes before crossing the pass.

Example: Upon completion of a dive at 2000 feet, the diver plans to fly home in an unpressurized aircraft at 5000 feet. The diver's repetitive group designator upon surfacing is Group K. What is the required surface interval before flying?

The planned increase in altitude is 3000 feet. Enter Table 9-5 at 3000 feet and read down to Repetitive Group K. The diver must delay 6 hours and 25 minutes before taking the flight.

Table 9-6. Unlimited/No-Decompression Limits and Repetitive Group Designation Table for Unlimited/No-Decompression Air Dives.

Depth (feet/meters)	No-Decompression Limits (min)	Group Designation															
		A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	
10	3.0	unlimited	60	120	210	300	797	*									
15	4.6	unlimited	35	70	110	160	225	350	452	*							
20	6.1	unlimited	25	50	75	100	135	180	240	325	390	917	*				
25	7.6	595	20	35	55	75	100	125	160	195	245	315	361	540	595		
30	9.1	405	15	30	45	60	75	95	120	145	170	205	250	310	344	405	
35	10.7	310	5	15	25	40	50	60	80	100	120	140	160	190	220	270	310
40	12.2	200	5	15	25	30	40	50	70	80	100	110	130	150	170	200	
50	15.2	100		10	15	25	30	40	50	60	70	80	90	100			
60	18.2	60		10	15	20	25	30	40	50	55	60					
70	21.3	50		5	10	15	20	30	35	40	45	50					
80	24.4	40		5	10	15	20	25	30	35	40						
90	27.4	30		5	10	12	15	20	25	30							
100	30.5	25		5	7	10	15	20	22	25							
110	33.5	20			5	10	13	15	20								
120	36.6	15			5	10	12	15									
130	39.6	10			5	8	10										
140	42.7	10			5	7	10										
150	45.7	5			5												
160	48.8	5					5										
170	51.8	5						5									
180	54.8	5							5								
190	59.9	5															

* Highest repetitive group that can be achieved at this depth regardless of bottom time.

Table 9-7. Residual Nitrogen Timetable for Repetitive Air Dives.

Locate the diver's repetitive group designation from his previous dive along the diagonal line above the table. Read horizontally to the interval in which the diver's surface interval lies.

Next read vertically downward to the new repetitive group designation. Continue downward in this same column to the row which represents the depth of the repetitive dive. The time given at the intersection is residual nitrogen time, in minutes, to be applied to the repetitive dive.

* Dives following surface intervals of more than 12 hours are not repetitive dives. Use actual bottom times in the Standard Air Decompression Tables to compute decompression for such dives.

** If no Residual Nitrogen Time is given, then the repetitive group does not change.

		Repetitive group at the beginning of the surface interval																
		Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A	
Repetitive Dive Depth		New Repetitive Group Designation																
feet/meters		Z	O	N	M	L	K	J	I	H	G	F	E	D	C	B	A	
10	3.0	**	**	**	**	**	**	**	**	**	**	**	**	797	279	159	88	39
20	6.1	**	**	**	**	**	**	917	399	279	208	159	120	88	62	39	18	
30	9.1	†	†	†	349	279	229	190	159	132	109	88	70	54	39	25	12	
40	12.2	257	241	213	187	161	138	116	101	87	73	61	49	37	25	17	7	
50	15.2	169	160	142	124	111	99	87	76	66	56	47	38	29	21	13	6	
60	18.2	122	117	107	97	88	79	70	61	52	44	36	30	24	17	11	5	
70	21.3	100	96	87	80	72	64	57	50	43	37	31	26	20	15	9	4	
80	24.4	84	80	73	68	61	54	48	43	38	32	28	23	18	13	8	4	
90	27.4	73	70	64	58	53	47	43	38	33	29	24	20	16	11	7	3	
100	30.5	64	62	57	52	48	43	38	34	30	26	22	18	14	10	7	3	
110	33.5	57	55	51	47	42	38	34	31	27	24	20	16	13	10	6	3	
120	36.6	52	50	46	43	39	35	32	28	25	21	18	15	12	9	6	3	
130	39.6	46	44	40	38	35	31	28	25	22	19	16	13	11	8	6	3	
140	42.7	42	40	38	35	32	29	26	23	20	18	15	12	10	7	5	2	
150	45.7	40	38	35	32	30	27	24	22	19	17	14	12	9	7	5	2	
160	48.8	37	36	33	31	28	26	23	20	18	16	13	11	9	6	4	2	
170	51.8	35	34	31	29	26	24	22	19	17	15	12	10	8	6	4	2	
180	54.8	32	31	29	27	25	22	20	18	16	14	11	10	8	6	4	2	
190	59.9	31	30	28	26	24	21	19	17	15	13	10	10	8	6	4	2	

Residual Nitrogen Times (Minutes)

† Read vertically downward to the 40/12.2 (feet/meter) repetitive dive depth. Use the corresponding residual nitrogen times (minutes) to compute the equivalent single dive time. Decompress using the 40/12.2 (feet/meter) standard air decompression table.