

Comparison of the air diving tables: DCIEM & ZH-86 with: DGUV Vorschrift 40 (*) and DIVE Version 3_09

DOI: 10.13140/RG.2.2.28277.40169
(german version)

(*) DGUV Vorschrift 40

reads

Deutsche Gesetzliche Unfallversicherung

in english:

German legal regulations for the prevention of
industrial accidents, rule # 40:
diving operations

As per January 2012

(previously this was the:
BGV C23 from 1.10.1979

the „BG“ here means:
Workmen's Compensation Board)

Link to download:

[https://publikationen.dguv.de/regelwerk/dguv-
vorschriften/1089/taucherarbeiten?c=13](https://publikationen.dguv.de/regelwerk/dguv-vorschriften/1089/taucherarbeiten?c=13)

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air diving tables:

ZH-86, DCIEM,
DGUV Vorschrift 40 (*)

with:

DIVE Version 3_09

DOI: 10.13140/RG.2.2.28277.40169

Abstract:

DGUV follows precisely the ZH-86 within the „*protective envelope*“ (< 30 m, < 30 min).
Marginal deviations of +/- 1 min per ZH-86 resp. DIVE Version 3_09 stem, among others, from different ascent rates.

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Outside this envelope „*executive editing*“ yields negative deviations, i.e.: truncated stop times due to a modulo 5 structure.

Methods:

Direct comparison of the air diving boxprofiles in the dimensions:

- stop times per stage and
- TTS

(TTS = time-to-surface, i.e.: sum of all stop-times + bottom depth / ascent rate)

Discussion:

Within this „*protective envelope*“ (depth < 30 m, time < 30 min) the DGUV Vorschrift 40 follows precisely the „original“ ZH-86. Deviations stem from differing ascent rates (ca. 12 (DGUV) vs. ca.10 (ZH-86) m/min) and as well from the slightly different ambient air pressure at the start of the dive (DGUV: 1 Bar).

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As comparison and control document we have the screen shots of DIVE Version 3_09. The deviations to the ZH-86 of ca. + 1 min for the deepest stages come from the slightly different sets of a-/b-coefficients: ZH-L 16B for the table and ZH-L 16C for dive computers resp. desktop software) and as well from the differing specific mass density for water, needed to calculate the hydrostatic pressure of the water column (ZH-86 uses the „non standard“ value of 1,02 kg/L.) For easier comparison, DIVE can toggle the so-called „Buehlmann safety factor“ (+ 3 % depth, + 1 m).

Discussion:

By leaving the protective envelope
there are negative
deviations relative to the ZH-86:
the stop times / TTS are truncated.

„executive editing“ is the method of manipulating
algorithmically calculated stop times in favor of
aesthetic or organisatorial ideas. But it does so
without any physiologic rationale!

This results in so-called „modulo 5“ pattern for the stop-times
(for e.g. in chart # 9, the yellow display is mine)
i.e.: $n * 5$ min for the shallow stops,
and leads to the deviations, described below.

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Results:

Due to the truncated stop times in places in comparison with the ZH-86 the DGUV # 40 should be used only within the protective envelope!

For dives > 30 m, > 30 min one should use only the „original“ ZH-86 or resp. the DCIEM tables!

The conformity of DIVE V 3_09 with ZH-86 is maximal: the above described deviations do not play any decisive role in practical diving: the hereby used instruments (dive computers, oxygen analyzers) are by far more inaccurate!

Dives with parameters outside the ZH-86 can be simulated with the topical DIVE Version 3_09 easily and accurately!

Used Tables:

Details: pls. cf. nxt. chart

→ **ZH-86: Luftdekompressionstabelle**
(Zürich 1986) 0 – 700 m ü. NN
(with coefficients according to ZH-L 16 B from
Albert Alois Buehlmann et al.

→ **Unfallverhütungsvorschrift Taucherarbeiten**
DGUV Vorschrift 40
(bisher BGV C23 vom 1.10.1979) mit der
Durchführungsanweisung vom Januar 2012
Attachment 1, Table 2: Air Diving Table, on p. 47 - 53

→ **Defence and Civil Institute of Environmental Medicine,**
Ontario, Canada;
DCIEM Diving Manual: Air Decompression Procedures and Tables
March 1992, DCIEM No. 86-R-35

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Tauchmedizin

Barotrauma
Gasembolie · Dekompression
Dekompressionskrankheit
Dekompressionscomputer

5. Auflage



Springer

**[65], Table 32
on p. 225 - 228**

Unfallverhütungsvorschrift Taucherarbeiten DGUV Vorschrift 40

(bisher BGV C23)

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Tauchzeit (min)	Aufstieg bis zur ersten Austausch- stufe (min:sec)	Haltezeiten während des Austauschens auf den Austauschstufen (min)						Gesamtzeit der Dekom- pression (min:sec)
		18 m	15 m	12 m	9 m	6 m	3 m	
Tauchtiefe 42 m								
7	3:30	–	–	–	–	–	–	3:30
10	3:15	–	–	–	–	–	3	6:15
15	3:00	–	–	–	–	3	5	11:00
20	3:00	–	–	–	–	3	12	18:00
25	2:45	–	–	–	3	7	17	29:45
30	2:45	–	–	–	5	10	25	42:45
35	2:30	–	–	3	7	15	30	57:30
40	2:30	–	–	3	10	20	35	70:30
45	2:30	–	–	5	12	25	40	84:30
50	2:30	–	–	5	15	25	45	92:30
60	2:15	–	3	10	17	30	60	122:15
70	2:15	–	5	12	25	40	75	159:15

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[28], Table 1
on p. 1B - 5 → 1B - 18

15 m / 240 min

ZH-86 / TTS = 72
2 / 69

DIVE / TTS = 73
3 / 69

DGUV / TTS = 61
60

DCIEM / TTS = 70

```

Deko Prognose:
6m Stopp Prognose Dekozeit:      3.0  Komp.#:  8
3m Stopp Prognose Dekozeit:      69.0  Komp.#: 10
TTS =      73.0

```

21 m / 70 min

ZH-86 / TTS = 26
24

DIVE / TTS = 26
24

```
Deko Prognose:  
3m Stopp Prognose Dekozeit:    24.0    Komp.#:    7  
TTS =        26.0
```

DGUV / TTS = 21,5
20

DCIEM / TTS = 20

21 m / 120 min

ZH-86 / TTS = 63
17 / 44

DIVE / TTS = 64
17 / 45

DGUV / TTS = 61,25
15 / 45

DCIEM / TTS = 61
7 / 54

```
niedriger wie Ceiling waehlen!  
Deko Prognose:  
6m Stopp Prognose Dekozeit:    17.0  Komp.#:  7  
3m Stopp Prognose Dekozeit:    45.0  Komp.#:  8  
TTS =      64.0
```

21 m / 180 min

ZH-86 / TTS = 130

4 / 37 / 88

DIVE / TTS = 130

5 / 39 / 85

DGUV / TTS = 121

5 / 40 / 75

DCIEM / TTS = 130

29 / 101

Deko Prognose:

9m Stopp Prognose Dekozeit: 5.0 Komp.#: 7

6m Stopp Prognose Dekozeit: 39.0 Komp.#: 8

3m Stopp Prognose Dekozeit: 85.0 Komp.#: 10

TTS = 130.0

30 m / 40 min

ZH-86 / TTS = 24
5 / 17

DIVE / TTS = 24
5 / 17

```
Deko Prognose:  
6m Stopp Prognose Dekozeit:      5.0  Komp.#:  4  
3m Stopp Prognose Dekozeit:      17.0  Komp.#:  6  
TTS =      24.0
```

DGUV / TTS = 24
5 / 17

DCIEM / TTS = 25
9 / 16

30 m / 50 min

ZH-86 / TTS = 41

1 / 10 / 28

DIVE / TTS = 42

2 / 11 / 27

DGUV / TTS = 37

10 / 25

DCIEM / TTS = 41

4 / 8 / 29

```
Deko Prognose:
9m Stopp Prognose Dekozeit:      2.0  Komp. #:  4
6m Stopp Prognose Dekozeit:     11.0  Komp. #:  6
3m Stopp Prognose Dekozeit:     27.0  Komp. #:  7
TTS =      42.0
```

30 m / 90 min

ZH-86 / TTS = 102
16 / 28 / 56

DIVE / TTS = 103
2 / 16 / 28 / 56

DGUV / TTS = 106,5
3 / 12 / 30 / 60

DCIEM / TTS = 109
2 / 8 / 24 / 75

niedriger wie ceiling wachen.

Deko Prognose:

12m Stopp Prognose Dekozeit:	1.0	Komp.#:	5
9m Stopp Prognose Dekozeit:	16.0	Komp.#:	6
6m Stopp Prognose Dekozeit:	28.0	Komp.#:	7
3m Stopp Prognose Dekozeit:	56.0	Komp.#:	9
TTS =	103.0		

42 m / 30 min

ZH-86 / TTS = 42
2 / 4 / 9 / 24

DIVE / TTS = 43
1 / 5 / 10 / 23

DGUV / TTS = 42,75
5 / 10 / 25

DCIEM / TTS = 46
4 / 6 / 8 / 28

```
Deko Prognose:
12m Stopp Prognose Dekozeit:      1.0  Komp. #:  3
 9m Stopp Prognose Dekozeit:      5.0  Komp. #:  4
 6m Stopp Prognose Dekozeit:     10.0  Komp. #:  5
 3m Stopp Prognose Dekozeit:     23.0  Komp. #:  7
TTS =      43.0
```

42 m / 35 min

(ZH-86: n.a.; 36 min
3 / 7 / 13 / 28; TTS = 54)

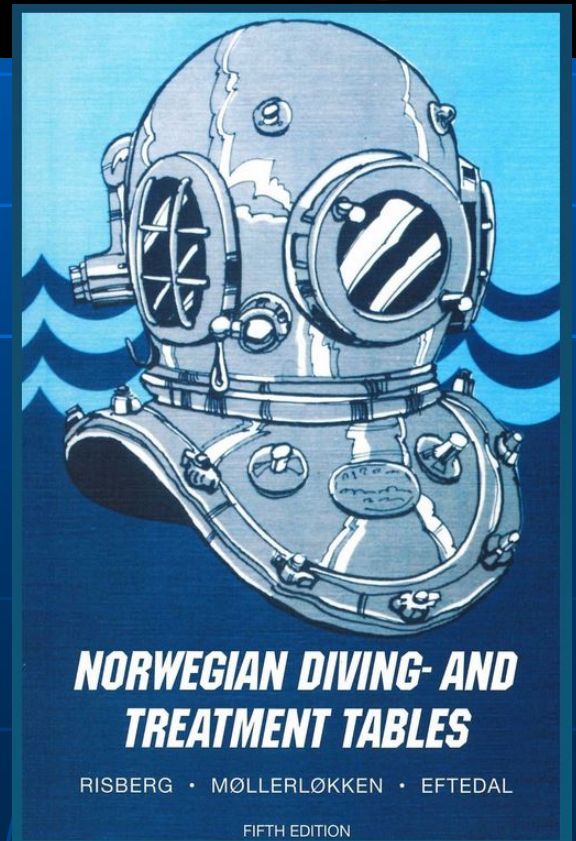
DIVE / TTS = 57
3 / 6 / 15 / 29

DGUV / TTS = 57,5
3 / 7 / 15 / 30

DCIEM / TTS = 58
5 / 7 / 9 / 37

NDTT 5.th edition, page 47 / TTS = 65
5 / 10 / 15 / 35

12m	Stopp	Prognose	Dekozeit:	3.0	Komp.#:	3
9m	Stopp	Prognose	Dekozeit:	6.0	Komp.#:	4
6m	Stopp	Prognose	Dekozeit:	15.0	Komp.#:	6
3m	Stopp	Prognose	Dekozeit:	29.0	Komp.#:	7
TTS =			57.0			



42 m / 70 min

ZH-86 / TTS: n.a.

-

DIVE / TTS = 173

1 / 8 / 15 / 24 / 40 / 80

DGUV / TTS = 159,25

5 / 12 / 25 / 40 / 75

DCIEM / TTS = 182

7 / 7 / 14 / 49 / 114

NDTT: n.a.

```
Deko Prognose:
18m Stopp Prognose Dekozeit:      1.0  Komp. #:  4
15m Stopp Prognose Dekozeit:      8.0  Komp. #:  5
12m Stopp Prognose Dekozeit:     15.0  Komp. #:  6
 9m Stopp Prognose Dekozeit:     24.0  Komp. #:  7
 6m Stopp Prognose Dekozeit:     40.0  Komp. #:  8
 3m Stopp Prognose Dekozeit:     80.0  Komp. #: 10
TTS =      173.0
```


48 m / 15 min

ZH-86 / TTS = 14
4 / 6

DIVE / TTS = 15
1 / 3 / 7

DGUV / TTS = 13,5
3 / 7

DCIEM / TTS = 20
4 / 6 / 10

```
Deko Prognose:
9m Stopp Prognose Dekozeit:      1.0  Komp.#:  2
6m Stopp Prognose Dekozeit:      3.0  Komp.#:  3
3m Stopp Prognose Dekozeit:      7.0  Komp.#:  4
TTS =      15.0
```

48 m / 30 min

ZH-86 / TTS = 57

5 / 6 / 13 / 30

DIVE / TTS = 58

1 / 4 / 7 / 14 / 28

DGUV / TTS = 58

3 / 7 / 15 / 30

DCIEM / TTS = 64

3 / 5 / 7 / 9 / 40

15m	Stopp	Prognose	Dekozeit:	1.0	Komp.#:	3
12m	Stopp	Prognose	Dekozeit:	4.0	Komp.#:	4
9m	Stopp	Prognose	Dekozeit:	7.0	Komp.#:	4
6m	Stopp	Prognose	Dekozeit:	14.0	Komp.#:	6
3m	Stopp	Prognose	Dekozeit:	28.0	Komp.#:	7
TTS =			58.0			

48 m / 60 min

ZH-86: n.a.

DIVE / TTS = 177

5 / 8 / 16 / 24 / 40 / 79

DGUV / TTS = 167,5

3 / 7 / 15 / 25 / 45 / 75

DCIEM / TTS = 201

6 / 5 / 8 / 17 / 43 / 122

```
Deko Prognose:
18m Stopp Prognose Dekozeit:      5.0  Komp. #:  4
15m Stopp Prognose Dekozeit:      8.0  Komp. #:  5
12m Stopp Prognose Dekozeit:     16.0  Komp. #:  6
 9m Stopp Prognose Dekozeit:     24.0  Komp. #:  7
 6m Stopp Prognose Dekozeit:     40.0  Komp. #:  8
 3m Stopp Prognose Dekozeit:     79.0  Komp. #: 10
TTS =      177.0
```

60 m / 35 min

ZH-86: n.a.

DIVE / TTS = 128

2 / 4 / 6 / 10 / 18 / 28 / 54

DGUV / TTS = 121,5

3 / 5 / 10 / 15 / 30 / 55

DCIEM / TTS = 146

5 / 4 / 5 / 6 / 10 / 32 / 84

Deko Prognose:

21m Stopp Prognose	Dekozeit:	2.0	Komp.#:	3
18m Stopp Prognose	Dekozeit:	4.0	Komp.#:	4
15m Stopp Prognose	Dekozeit:	6.0	Komp.#:	4
12m Stopp Prognose	Dekozeit:	10.0	Komp.#:	5
9m Stopp Prognose	Dekozeit:	18.0	Komp.#:	6
6m Stopp Prognose	Dekozeit:	28.0	Komp.#:	7
3m Stopp Prognose	Dekozeit:	54.0	Komp.#:	9
TTS =		128.0		

Is this another serious PoC for DIVE Version 3_09?

→ DIVE V 3_09 (https://www.divetable.info/DIVE_V3/index.htm)
and the

→ manual are in german:
(https://www.divetable.info/DIVE_V3/DOXV3_0.pdf)

The release train for

→ the english version (V3_04) is somewhat slower ...

https://www.divetable.info/DIVE_V3/V3e/index.htm

Fine tuning of DIVE:

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Fine tuning could be done via the commands:

- ascent rate („**AR**“)
- ambient atmospheric pressure at start („**L**“)
- the respiratory coefficient („**R**“)
- the ambient (water)-temperature („**te**“)
- the water density („**di**“)

```
            niedriger wie bei dem wachsten.  
Deko Prognose:  
15m Stopp Prognose Dekozeit: 12.0 Komp. #: 8  
12m Stopp Prognose Dekozeit: 24.0 Komp. #: 10  
9m Stopp Prognose Dekozeit: 38.0 Komp. #: 11  
6m Stopp Prognose Dekozeit: 80.0 Komp. #: 13  
3m Stopp Prognose Dekozeit: 159.0 Komp. #: 16  
TTS = 316.0
```

And with:

„**a**“

we receive the complete decompression prognosis;

i.e.: the stop times in min per stage, modulo 3 m

and the responsible leading compartment & the rounded up TTS in min.

The latest DIVE Version for beta testing is always staged there:

<https://www.divetable.info/beta/index.htm>

along with information on production date, size in bytes, new features and the checksums for verifying the download.

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ALBI @ Crete:
Yippie yaa yeah,
let's search
the next
200 kg bomb ...