

STEL AND TWA: HOW DUSTLIGHT EVALUATES EXPOSURE

Dust exposure at work is normally assessed against two limits: the TWA and the STEL. The **TWA** (time-weighted average) is the average concentration over a full shift; its limit protects against long-term exposure. The **STEL** (short-term exposure limit) caps concentration peaks, evaluated as 15-minute averages. This note explains both, what a short-term period is — and how Dustlight calculates them live on the device and in the app. Both values describe the whole working day — so they are only meaningful if Dustlight is worn for the entire shift.

FOR	TOPIC	APPLIES TO	PLANS
HSE managers and safety officers	STEL & TWA — how Dustlight evaluates exposure	Dustlight device, mobile app & web app	Device: all plans · App & web app: Business, Corporate

01 TWA—THE AVERAGE OVER THE SHIFT

The **TWA (time-weighted average)** is the average concentration over a standard **8-hour shift** — brief peaks are allowed as long as the shift as a whole stays below the limit value. Dustlight recalculates it every minute:

$$\text{TWA}_{\text{current}} = \underbrace{\sum_{n=1}^N \frac{\text{Samples}(n)}{N}}_{\text{average concentration so far}} \times \underbrace{\frac{t_{\text{measured}}}{8 \text{ h}}}_{\substack{\text{hours measured} \\ \text{so far} \\ \text{out of 8 h}}}$$

N = number of samples since midnight

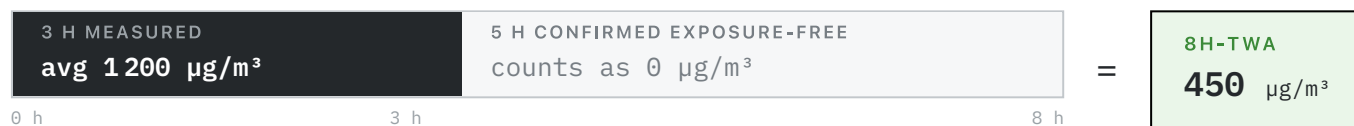
$$t_{\text{measured}} = \text{device measuring time since midnight}$$

DUSTLIGHT EVALUATION DAY · MIDNIGHT TO MIDNIGHT

Many instruments restart their evaluation at power-on — Dustlight does not.

Dustlight evaluates one calendar day — from **midnight to midnight**, on the device and in the app alike. All minutes since midnight in which the device was measuring count; switching off and on continues the same day. STEL and TWA reset when limit value, material, country or timezone change. The evaluation day may differ from the regulatory shift period — a night shift 22:00–06:00 is split at midnight. For a formal assessment, the applicable shift period must be considered.

WORKED JUST 3 HOURS? STILL DIVIDED BY 8 H



Limit values are defined for 8-hour shifts, so a shorter measurement still counts against the full 8 hours. Exposure-free periods count as 0 $\mu\text{g}/\text{m}^3$ — time in which exposure is unknown must not automatically be treated as exposure-free. Dustlight counts every minute without a reading as 0 $\mu\text{g}/\text{m}^3$ — measuring only 2 of 8 working hours therefore makes the TWA look lower than the real exposure.

Work shift longer than 8 h? Dustlight lets you adjust the shift length in the settings. The TWA limit value is then reduced according to the **Brief & Scala model**, and the TWA is calculated over the adjusted shift length.

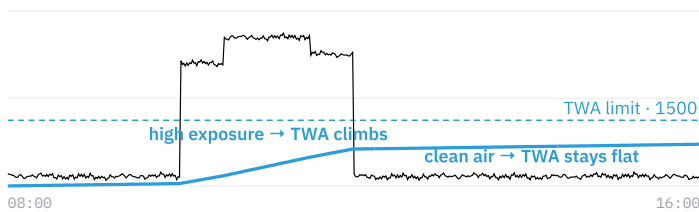
READING THE TWA — TWO WAYS TO SEE IT

The same TWA is shown in two forms: as a concentration curve in the app and web app, and as a dose percentage on the device.

IN THE APP & WEB APP · TWA IN $\mu\text{g}/\text{m}^3$

The 8h-TWA line is **cumulative**: at every point it averages all readings taken since midnight against the full 8 hours. It only ever rises — a clean hour flattens it, a peak steepens it (Graph 1). A gauge next to it shows the same value as dose.

— Direct readings ($\mu\text{g}/\text{m}^3$) — 8h-TWA (cumulative)



Graph 1 The 8h-TWA (blue) climbs steeply while exposure is high and flattens once the air is clean — it never falls.

ON DUSTLIGHT · TWA AS DOSE IN %



The dose — the share of the daily allowance already used — is also in the app, but what matters is having it **in real time on Dustlight**, right at the workplace.

$$\text{Dose} = \frac{\text{TWA}_{\text{current}}}{\text{TWA limit}} \times 100 \%$$

Example (TWA limit 2000 $\mu\text{g}/\text{m}^3$):

$450 \mu\text{g}/\text{m}^3 \div 2\,000 \mu\text{g}/\text{m}^3 = 22.5 \%$ — shown as TWA 23 % on the display.

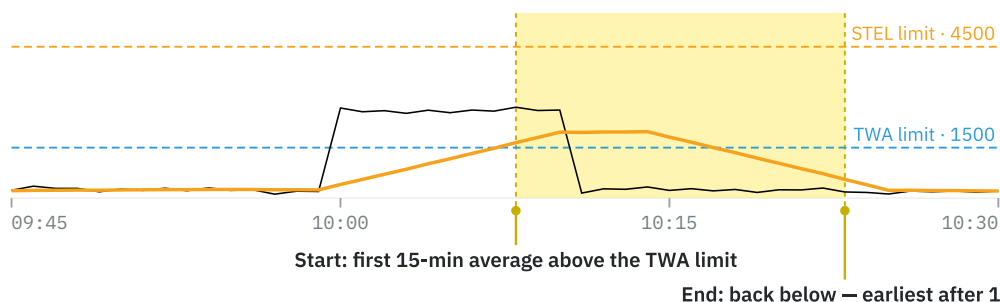
The dose turns **yellow** above the TWA warning level (default 10 %) and **red** above the TWA limit (100 %).

02 STEL — THE 15-MINUTE VIEW

The TWA shows *how much* exposure occurred over the day, but not *when*. The **STEL (short-term exposure limit)** adds this time dimension: it limits concentration peaks, so the daily allowance is not used up in a few intense episodes. The STEL is based on the **moving 15-minute average** — the mean of the last 15 minutes of readings, updated every minute and shown live as STEL on the device. For most dust types no substance-specific STEL limit is defined; many countries instead apply a general **exceedance factor** to the TWA limit, which then gives the STEL limit.

$$\text{Moving 15-min average (STEL}_{\text{current}}) = \sum_{n \text{ in last 15 min}} \frac{\text{Samples}(n)}{15}$$

— Direct readings ($\mu\text{g}/\text{m}^3$) — Moving 15-min average (STEL_{current}) — TWA limit — STEL limit — Short-term period



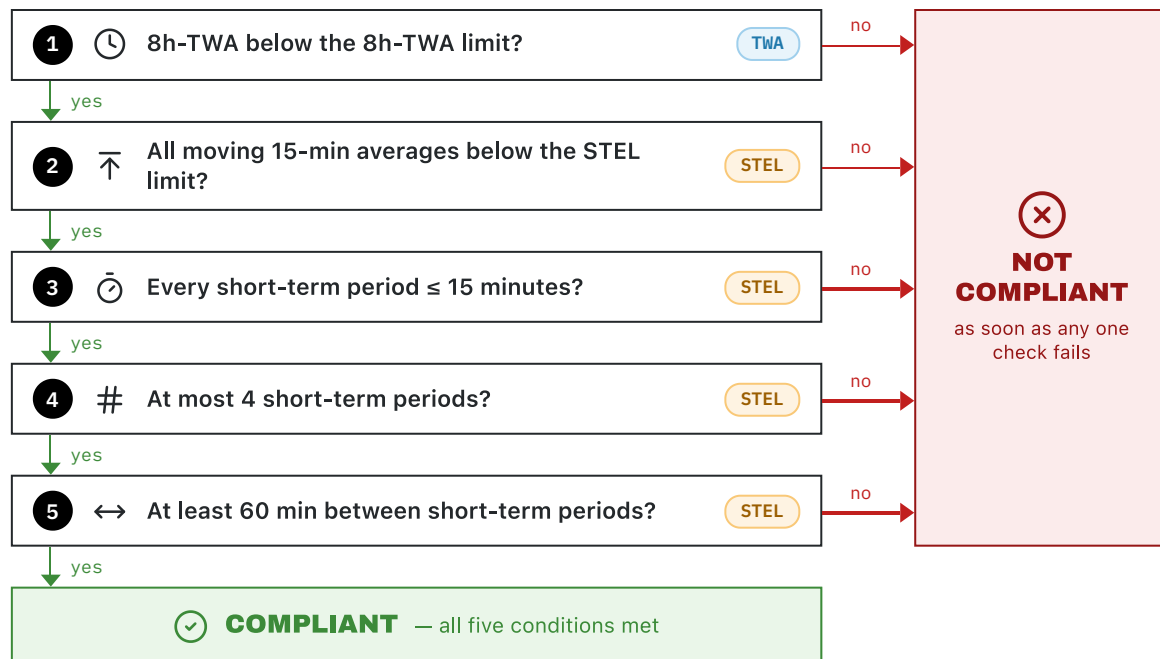
Graph 2 Anatomy of a short-term period, zoomed to 45 min around the burst. Example values: TWA limit 1500 $\mu\text{g}/\text{m}^3$, exceedance factor 3 → STEL limit 4500 $\mu\text{g}/\text{m}^3$. The average trails the raw signal by a few minutes — that is the averaging, not a device delay.

Whenever the moving 15-minute average rises **above the TWA-limit value**, a **short-term period** begins. It ends when the average falls back below the TWA limit — **but always lasts at least 15 minutes**. Regulations do not forbid such periods, they constrain them: how high, how long, how many, how far apart — the five conditions on the next page.

03 COMPLIANCE — THE FIVE CONDITIONS DUSTLIGHT CHECKS

Every minute Dustlight recalculates the running TWA and the moving 15-minute average, detects short-term periods and re-evaluates all five conditions for the current measurement day. The result is a single verdict per shift — **compliant** or **not compliant** — shown in the app together with the state you are in right now (e.g. “you are currently in a short-term period”).

Flowchart 1 The five checks, in the order Dustlight runs them



Flowchart 1 Values shown — 15 min maximum length, at most 4 periods, 60 min spacing — are the common regulatory defaults used in the examples; they are configurable per country and material. Short-term periods can only be detected while the device is measuring — a *compliant* verdict therefore covers the measured time only.

04 WORKED EXAMPLES

Six example days, evaluated with the checks above. All graphs on the next page use the same example configuration:

- TWA limit $1500 \mu\text{g}/\text{m}^3$ · exceedance factor 3 → STEL limit $4500 \mu\text{g}/\text{m}^3$
- Short-term period length $\leq 15 \text{ min}$ · at most 4 short-term periods per day · $\geq 60 \text{ min}$ break between short-term periods

Please note: Dustlight measures respirable dust optically and is intended for orienting, real-time exposure assessment. A formal workplace exposure assessment requires a measurement method and strategy suitable for the applicable regulatory requirements; depending on the substance and regulatory context, additional or reference measurements may be required. Limit values, exceedance factors, period length, count and spacing are configurable and must follow the regulations that apply to your site and material. All example values on these pages are illustrative.

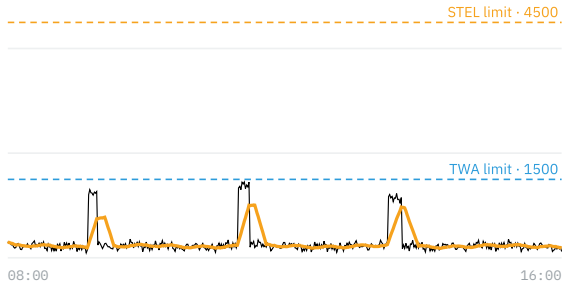
References: Emmel, C., Vossen, K., Koppisch, D. (2023): Beurteilung von Konzentrationsspitzen am Arbeitsplatz — eine Arbeitshilfe. Gefahrstoffe 83, Nr. 07-08 · TRGS 900, TRGS 402 (short-term value concept used here as the reference framework; terminology on these pages follows the international STEL/TWA convention).

— Direct readings ($\mu\text{g}/\text{m}^3$) — Moving 15-min average (STEL _{current}) - - - TWA limit - - - STEL limit

■ Short-term period

Everything below the limit

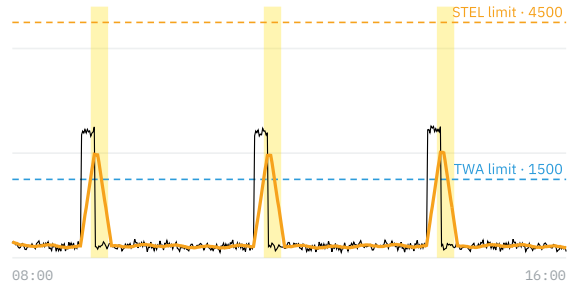
COMPLIANT



Graph 3a The raw signal spikes, but no 15-min average crosses the TWA limit. No short-term periods exist; nothing further to check.

Three short-term periods, all rules kept

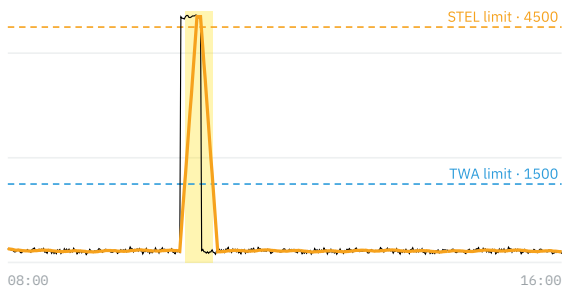
COMPLIANT



Graph 3b Three periods (yellow), each ≤ 15 min, well below the STEL, more than an hour apart, count ≤ 4 . All five conditions hold.

One 15-min average above the STEL

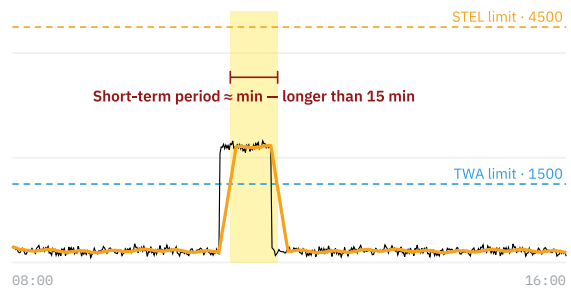
NOT COMPLIANT



Graph 3c The moving average itself tops the STEL (condition 2) — not compliant, however short or rare the burst.

Short-term period longer than 15 minutes

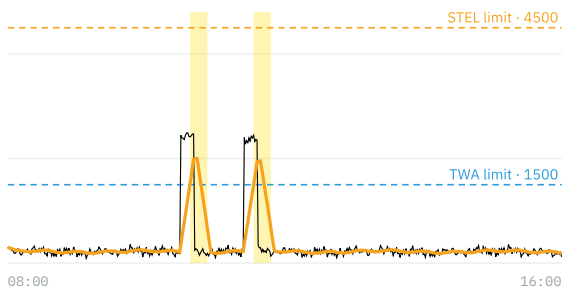
NOT COMPLIANT



Graph 3d The average stays above the TWA limit for ≈ 40 min; condition 3 caps a period at 15 min — not compliant.

Two short-term periods less than 1 h apart

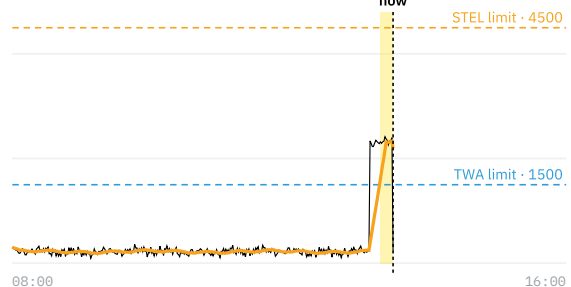
NOT COMPLIANT



Graph 3e Two valid periods (each ≤ 15 min, below the STEL) — but the second starts ≈ 40 min after the first ended. The break is shorter than 60 min, so condition 5 is violated $\rightarrow$ not compliant.

Live: a period is running right now

IN PROGRESS



Graph 3f The average crossed the TWA limit ≈ 10 min ago and is still above it. The app already reports “you are currently in a short-term period”; the verdict stays open until the period ends. If it is still above the limit after 15 min, the day turns not compliant.