D. FORMULAE FOR RESULTS

D.1. BASIC RESULTS – RMS, VDV, CRF, OVL, PEAK, P-P, MTVV

NOTATION

T - measurement time

$\mathbf{T_E}$ - exposure time (period during which a person is exposed to the action of vibration).

$\mathbf{T_0}$ - period equal to 8 hours (28 800 seconds)

$\boldsymbol{\tau}$ - detector time constant (τ =1s)

$\mathbf{a_W(t)}$ - the temporary value of the measured vibration with the weighting filter **W** (e.g. **Wd**) on the input of the RMS detector

$\mathbf{p_W(t)}$ - the temporary value of the measured vibration with the weighting filter **W** (e.g. **Wd**) on the output of the RMS detector calculated from the equation:

$$\mathbf{p_W(t) = \left(\frac{1}{\tau} \int_{-\infty}^{t} a_W^2(t_x) \exp\left(\frac{t_x - t}{\tau} \right) dt_x \right)^{1/2}}$$

where:

$\mathbf{t_x}$ - time (variable of the integration)

For **RMS**, **VDV**, **PEAK**, **PEAK-PEAK**, **MTVV** results when saved in the logger T is equal to logger step

For **RMS**, **VDV**, **PEAK**, **PEAK-PEAK**, **MTVV** results when saved as the main results T is equal to measurement period value

FORMULAE

RMS

The **R**oot **M**ean **S**quare result is calculated as follows:

$$\mathbf{RMS = \left(\frac{1}{T} \int_{0}^{T} a_W^2(t)\, dt \right)^{1/2}}$$

VDV

The **V**ibration **D**ose **V**alue result (expressed in $m/s^{1.75}$) as follows:

$$\mathbf{VDV = \left(\int_{0}^{T} a_W^4(t)\, dt \right)^{1/4}}$$

CRF

The **Cr**est **F**actor value is obtained from the proportion **PEAK**/**RMS**.

OVL

The **Ov**er**l**oad presents the percentage of the time the input signal was overloaded.

PEAK

The **PEAK** value is calculated for the given **T** as follows:

$$\mathbf{PEAK = max_T \left| a_W(t) \right|}$$

P–P

The **P**eak to **P**eak result is calculated as follows:

$$\mathbf{P-P = max_T\left(0, a_W(t)\right) - min_T\left(0, a_W(t)\right)}$$

MTVV

The **M**aximum **T**ransient **V**ibration **V**alue is defined (according to the **ISO 8041** standard) as:

$$\mathbf{MTVV = max_T\left(p_W(t)\right)}$$

D.2 HAND-ARM DOSIMETER RESULTS - MAX(RMS), EAV TT, EAV TL, ELV TT, ELVTL, AEQ, Current Exposure, Daily Exposure

NOTATION

EAV - **E**xposure **A**ction **V**alue – constant value defined by USER or defaultly set for U.K., Italy, France, Germany, - according to local standards (in Poland **MNDN8h** value)

ELV - **E**xposure **L**imit **V**alue – constant value defined by USER or defaultly set for U.K., Italy, France, Germany – according to local standards (in Poland **MDND30** value)

MAX(RMS)

The **MAX(RMS)** result is the highest **RMS** value taken from three axis

$$\mathbf{MAX(RMS) = max\left\{ RMS_x, RMS_y, RMS_z \right\}}$$

EAV Total Time

The **EAV Total Time** result is calculated as follows:

$$\mathbf{EAV_{TT} = T_0\left(\frac{EAV}{AEQ}\right)^2}$$

EAV Time Left

The **EAV Time Left** result is calculated as follows:

$$\mathbf{EAV_{TL} = EAV_{TT} - T}$$

ELV Total Time

The **ELV Total Time** result is calculated as follows:

$$\mathbf{ELV_{TT} = T_0 \left(\frac{ELV}{AEQ} \right)^2}$$

ELV Time Left

The **ELV Time Left** result is calculated as follows:

$$\mathbf{ELV_{TL} = ELV_{TT} - T}$$

MNDN Total Time (result only for polish standards)

The **MNDN Total Time** result is calculated as follows:

$$\mathbf{MNDN_{TT} = T_0 \left(\frac{MNDN8h}{AEQ} \right)^2}$$

MNDN Time Left (result only for polish standards)

The **MNDN Time Left** result is calculated as follows:

$$\mathbf{MNDN_{TL} = MNDN_{TT} - T}$$

AEQ (HAND-ARM VECTOR)

The **AEQ** result is calculated as follows:

$$\mathbf{AEQ = \sqrt{RMS_x^2 + RMS_y^2 + RMS_z^2}}$$

Current Exposure

The **Current Exposure** result is calculated as follows:

$$\mathbf{CExp = AEQ \sqrt{\frac{T}{T_0}}}$$

Daily Exposure

The **Daily Exposure** result is calculated as follows:

$$\mathbf{A(8) = AEQ \sqrt{\frac{T_E}{T_0}}}$$

D.3 WHOLE-BODY DOSIMETER RESULTS – MAX(RMS), MAX(VDV), EAV TT, EAV TL, ELV TT, ELV TL, Current Dose, Daily Dose, Current Exposure, Daily Exposure, Vector

NOTATION

EAV - **E**xposure **A**ction **V**alue – constant value defined by USER or defaultly set for U.K., Italy, France, Germany according to local standards (in Poland **ONDN8h** value)

$\mathbf{EAV_A}$ - **E**xposure **A**ction **V**alue expressed in $\frac{m}{s^2}$

$\mathbf{EAV_V}$ - **E**xposure **A**ction **V**alue expressed in $\frac{m}{s^{1.75}}$ (this unit may be selected in USER option)

ELV - **E**xposure **L**imit **V**alue – constant value defined by USER or defaultly set for U.K., Italy, France, Germany according to local standards (in Poland **ONDN30** value)

$\mathbf{ELV_A}$ - **E**xposure **L**imit **V**alue expressed in $\frac{m}{s^2}$

$\mathbf{ELV_V}$ - **E**xposure **L**imit **V**alue expressed in $\frac{m}{s^{1.75}}$ (this unit may be selected in USER option)

$\mathbf{k_{x,y,z}}$ - weighting factors for x, y, z axis

MAX(RMS)

The **MAX(RMS)** result is the highest weighted RMS value taken from three axis

$$\mathbf{MAX(RMS) = max\left\{ 1.4RMS_x, 1.4RMS_y, RMS_z \right\}}$$

MAX(VDV)

The **MAX(VDV)** result is the highest weighted VDV value taken from three axis

$$\mathbf{MAX(VDV) = max\left\{ 1.4VDV_x, 1.4VDV_y, VDV_z \right\}}$$

EAV Total Time

The **EAV Total Time** result is calculated as follows:

$$\mathbf{EAV_{TTA} = min\left\{ EAV_{TTAx}, EAV_{TTAy}, EAV_{TTAz} \right\}}$$

$$\mathbf{EAV_{TTAx,y,z} = T_0\left(\frac{EAV_{Ax,y,z}}{RMS_{x,y,z}}\right)^2}$$

$$\mathbf{EAV_{TTV} = min\left\{ EAV_{TTVx}, EAV_{TTVy}, EAV_{TTVz} \right\}}$$

$$\mathbf{EAV_{TTVx,y,z} = T\left(\frac{EAV_{Vx,y,z}}{VDV_{x,y,z}}\right)^4}$$

$$EAV_{TT} = \begin{cases} EAV_{TTA} \text{ if EAV limit is in } \dfrac{m}{s^2} \\ EAV_{TTV} \text{ if EAV limit is in } \dfrac{m}{s^{1.75}} \end{cases}$$

EAV Time Left

The **EAV Time Left** result is calculated as follows:

$$EAV_{TL} = EAV_{TT} - T$$

ELV Total Time

The **EAV Total Time** result is calculated as follows:

$$ELV_{TTA} = \min\left\{ ELV_{TTAx}, ELV_{TTAy}, ELV_{TTAz} \right\}$$

$$ELV_{TTAx,y,z} = T_0 \left(\frac{ELV_{Ax,y,z}}{RMS_{x,y,z}} \right)^2$$

$$ELV_{TTV} = \min\left\{ ELV_{TTVx}, ELV_{TTVy}, ELV_{TTVz} \right\}$$

$$ELV_{TTVx,y,z} = T \left(\frac{ELV_{Vx,y,z}}{VDV_{x,y,z}} \right)^4$$

$$ELV_{TT} = \begin{cases} ELV_{TTA} \text{ if ELV limit is in } \dfrac{m}{s^2} \\ ELV_{TTV} \text{ if ELV limit is in } \dfrac{m}{s^{1.75}} \end{cases}$$

ELV Time Left

The **ELV Time Left** result is calculated as follows:

$$ELV_{TL} = ELV_{TT} - T$$

ONDN Total Time (result only for polish standards)

The **ONDN Total Time** result is calculated as follows:

$$ONDN_{TT} = T_0 \left(\frac{ONDN8h}{Vector} \right)^2$$

ONDN Time Left (result only for polish standards)

The **ONDN Time Left** result is calculated as follows:

$$ONDN_{TL} = ONDN_{TT} - T$$

Current Dose

The **Current Dose** result is calculated as follows:

$$\mathbf{CDose = VDV}$$

Daily Dose

The **Daily Dose** result is calculated as follows:

$$\mathbf{DDose = VDV}\sqrt[4]{\frac{T_E}{T}}$$

Current Exposure

The **Current Exposure** result is calculated as follows:

$$\mathbf{CExp = RMS}\sqrt{\frac{T}{T_0}}$$

Daily Exposure

The **Daily Exposure** result is calculated as follows:

$$\mathbf{A(8) = RMS}\sqrt{\frac{T_E}{T_0}}$$

Vector

The **Vector** result is calculated as follows:

$$\mathbf{Vector} = \sqrt{(k_x RMS_x)^2 + (k_y RMS_y)^2 + k_z RMS_z^2}$$

Defaultly **Vector** is calculated as follows:

$$\mathbf{Vector} = \sqrt{(1.4 RMS_x)^2 + (1.4 RMS_y)^2 + RMS_z^2}$$

D.4 CALCULATOR RESULTS – A(8), Dose(8)

NOTATION

NFiles –	number of result files
$\mathbf{T_E(i)}$ –	exposure time for i-file in seconds
T(i) -	measurement time for i-file
$\mathbf{A_{x,y,z}(8)}$ -	results for x, y, z axis
$\mathbf{Dose_{x,y,z}(8)}$ -	results for x, y, z axis
$\mathbf{k_{x,y,z}}$ -	weight factors for x, y, z axis

Hand-Arm Daily

The **Hand – Arm Daily** result is calculated as follows:

$$A(8) = \sqrt{\sum_{i=1}^{NFiles} \left(\frac{T_E(i)}{28800} \right) VEC_{HA}{}^2(i)},$$

where $VEC_{HA}(i) = AEQ = \sqrt{RMS_x^2 + RMS_y^2 + RMS_z^2}$

Whole-Body Vibration Daily

The **Whole-Body Vibration Daily** results are calculated as follows:

$$A_{x,y,z}(8) = \sqrt{\sum_{i=1}^{NFiles} \left(\frac{T_E(i)}{28800} \right) k_{x,y,z}^2 RMS_{x,y,z}^2}$$

$$A(8) = MAX\{ A_x(8), A_y(8), A_z(8) \}$$

$$Dose_{x,y,z}(8) = \sqrt[4]{\sum_{i=1}^{NFiles} \left(\frac{T_E(i)}{T(i)} \right) k_{x,y,z}^4 VDV_{x,y,z}^4}$$

$$Dose(8) = MAX\{ Dose_x(8), Dose_y(8), Dose_z(8) \}$$