Tabelle 5.22:

Calculation of the maximum recommended Power Fempf

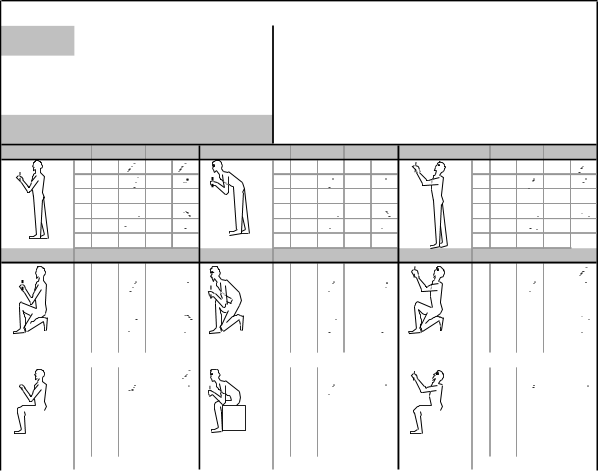
| Fempf | = | Fmax (PP) | \* | P1 | \* | P2 | \* | T1 | \* | T2 | \* | T3 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |

This applies to:

| Abbreviations | Descriptions |
| --- | --- |
| Fmax | Maximum static action force of the whole body  - or Finger-Hand-Systems |
| PP | Force-Percentile value  (P15 for planning analysis; P50 for Ist-Analysis) |
| P1 | Dependent on the direction of the force. Influence of age. |
| P2 | Gender Influence  (1,0 = Man; 0,5 = Wife or Man and Wife) |
| T1 | Frequency of the force application |
| T2 | Biomechanical - Factor  (muscular strain, asymmetric posture, a-/ ambidexterous force applied) |
| T3 | Physiology-Factor  (frequency of the power exercises in unfavorable postures, Strength exercises within long-running unfavorable stance phase) |

The maximum force value for the whole body -and Finger-Hand-Force are given in the table 5.23 and 5.4. They are a part of table 5.17 till 5.20. (See also appendix D and E).

Table 5.23:

Maximum force value of the whole body – Systems for Planning and 1st analysis

**Assembling-Specific Force Atlas**

F max All value in Newton [N]

Whole body forces, ambidextrous, Men

(Correcting factor for women value 0,5)

The specified values are the results of the force vectors of 5 N rounded.

P15: 15. Men the force percentage (for Planning analysis)

P50: 50. Male Force percentage (for Ist-Analysis)

Upright

P15 P50

Bent

P15 P50

Over Head

P15 P50

+A 380 515 +A 320 485 +A 360 455

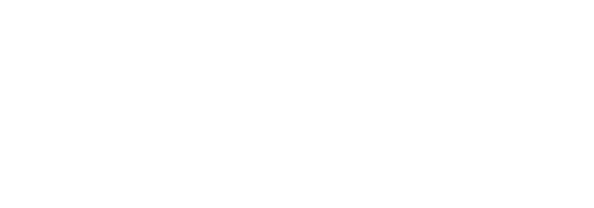
-A 405 530 -A 305 405 -A 410 520

+B 260 340 +B 315 420 +B 245 330

-B 380 505 -B 440 645 -B 395 525

+C 205 315 +C 225 335 +C 160 235

-C 170 280 -C 140 230 -C 150 235

stays - Upright h = 1 500 mm

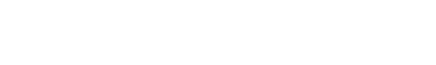
Bent

h = 1 100 mm

Overhead

h = 1 700 mm

Table 5.24:

Maximum force value of the Finger-Hand-Systems for Planning- and Ist-Analysis

| Assembly Specific Force Atlas |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Fmax | Finger-Hand-Force Men(Correction factor for women: 0,5) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Force gradient | Ø 40 mm |  |  |  | Clearance 15 mm |  | Clearance15 mm |  | Cross Width  e 65 mm |  |  |  |  |  | Cross Width  e 51 mm |  |
| Posture | Sit en | Stand | Sit en | Stand | Sit en | Stand | Sit en | Stand | Sit en | Stand | Sit en | Stand | Sit en | Stand | Sit en | Stand |
| 15. Percentile | 255 | 230 | 100 | 125 | 80 |  | 70 |  | 245 |  | 175 | 335 | 65 |  | 85 |  |
| 50. Percentile | 365 | 340 | 145 | 170 | 105 |  | 90 |  | 340 |  | 260 | 450 | 85 |  | 115 |  |

For Planning Analysis the 15. Force percentile of the table 5.23 and 5.24 should be used; for the 1st Analysis. The 50 percentile, possibly taking into account the gender and the “training unit”. We can find note on the age influence (Factor P1) in table 5.15 (Page 188). The activity related parameter (T1 till T3) we can find

in table 5.10 till 5.12 and 5.25. The frequency as well as the biomechanical and

physiological correction factors are taken into consideration in the activity related parameters.

For the planning analysis the frequency according to EN 1005-3 is taken into account. For the first analysis the traditional German methods (Siemens and derivatives according to Burandt und Schultetus as well as VDI, REFA and Bullinger) are taken into account. For the assembly specific Force Atlas the Schultetus method is selected[18], which distinguishes between the two difficult and one-sided dynamic force exercises. And the more dynamic frequency influence take into account the method defined by Siemens and Burandt (and Bullinger) (see also section 5.15). Also according to EN 1005-3, the force applied and the exertion duration should be abandoned in > 3 seconds, as he describes here in Table 5.24 a static rather than a dynamic force exercise. Table 5.25 gives an overview taking into account the frequency of force exercises in the different methods.

Table 5.25:

Taking into account the frequency of the force exercise in the method according to EN 1005-3 and Schultetus

| Frequency per Minute | 0 | 0,5 | 0,67 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frequency per 8h |  | 240 | 322 | 480 | 960 | 1440 | 1920 | 2400 | 2880 | 3360 | 3840 | 4320 | 4800 | 5280 | 5760 |  |
| T1 according to Schultetus (Finger‐Hand‐Force) | 0,80 | 0,75 | 0,74 | 0,72 | 0,67 | 0,66 | 0,63 | 0,61 | 0,58 | 0,57 | 0,55 | 0,54 | 0,52 | 0,51 | 0,50 |  |
| T1 according to Schultetus (Whole body force) | 0,80 | 0,68 | 0,67 | 0,64 | 0,59 | 0,54 | 0,50 | 0,45 | 0,41 | 0,37 | 0,34 | 0,30 | 0,27 | 0,24 | 0,21 |  |
| T1 according to EN 1005‐3; t\*) ≤ 3 sec | 0,80 | 0,64 |  |  | 0,40 |  |  |  |  |  |  |  |  |  |  |  |

\*) t = Tension durarion of the force exercise

A description of the “Biomechanical factors”, in which the influence of asymmetry, one hand versus ambidextrous force exercise and inner muscular tension is taken into view, we can find in the section 5.2.1 (Page 182 ff.). The same applies for the “ Physiological factor” in which the usual force exercise is carried out in which unfavorable postures for the body are adopted and the force actions is done in phases which are long-drawn- out and are unfavorable to the body.

5.4 Literature References.

[1] Directive 89/391 / EWG of the Council of 12 June 1989 on the introduction of measures to improve the safety and health of workers at work. ABl. EG Nr. L 183 from 29.6.1989, S. 1-8

[2] Workplace – New Regulation for the Safety and health protection: Publisher: Federal Minister for Work and Social Affairs (BMA). Roco Druck Gmbh, Wolfen- büttel 1997

[3] Directives 2006/42/EG of the European Parliament and the Council of 17th May

2006 for machinery and the amending of the directives 95/16/EG (Re cast). ABl.

EU Nr. L 157 (2006), S. 24-86; with rectification 2006/42/EG of the directives of the European Parliament and of the Council of 17 May 2006 on machinery, and amending directive 95/16/EC of 9 June 2006 ABl. EU Nr. L 76 (2007), S. 35

[4] Guiding method for the assessment of the Lifting, Holding and Carrying. Publisher: Federal Institute for Occupational Safety and Health Medicine (BAuA), Dortmund.

<http://www.baua.de/de/Themen-von-A-Z/Physische->

[Belastung/Gefaehrdungsbeurteilung.html](http://www.baua.de/de/Themen-von-A-Z/Physische-Belastung/Gefaehrdungsbeurteilung.html)

[5] Schaub, K.; Bookock, M.; Greve, R.; Kapitaniak, B.; Ringelberg, A.: The imple- mentation of risk assessment models for musculoskeletal disorders in CEN standards. In: Sjøgaard, G.; Fallentin, N. (eds.): Proceedings of the Symposium”Risk Assessment for Musculoskeletal Disorders”. Nordic Satellite Symposium under the auspices of ICOH ’96. Copenhagen, Denmark 13 to 14 September 1996, S. 73-74. Det Nationale Forskningscenter for Arbejdsmiljø.

[6] Schaub, K.; Berg, K.; Wakula, J.: Postural and workplace related influences on maximal force capacities. In: Seppäla, P.; Luopajärvi, T.; Nygard, C.-H.; Mattila,

M. (Publisher.): From experience to innovation, IEA ’97. Proceedings of the 13th Tri- annual Congress of the International Ergonomics Association, Tampere, Finland, 29 June to 4 July 1997, Vol. 4, S. 219-221. Finnish Institute of Occupational Health, Helsinki, Finnland 1997

[7] Schaub, K.: Evaluation of physical workload by means of IAD-BkA. Paper presentation at the 2nd International Conference on Occupational Risk Prevention, 20 to 22 February 2002, Gran Canaria, Spain.

[8] Schaub, K.; Storz, W.; Landau, K.: Sustainable Risik assessment during the assembling process in the automobile industry.. In: Landau, K.; Luczak, H. (Publisher): Ergonomics and Organisation during assembling work. Hanser, München 2001

[9] Schaub, K.: Winter, G.: Design - Check: A screening method for the assessment of physical stress. The Orthopaedist 31 (2002) Nr. 10, S. 987-996

[10] Instructions for the handling of bricks. Publisher: Federations of trade cooperatives, central office for the prevention of accidents and occupational medicine, specialized committees “Construction” Carl Heymanns, Köln 1992

[11] Hettinger, T. (Publisher.): Lifting and carrying loads: Advice regarding weight limits for Men, Women and Youth. Publisher: Federal ministry for Labour and Social Affairs Bonn 1981

[12] Steinberg; U.; Behrendt, S.; Bradl, I.; Caffier, G.; Gebhardt, H. J.; Liebers, F.; Müller, B. H.; Schäfer, A.; Schlicker, M.; Schulze, J.: Testing and evaluation of the safety and health protection guide book when there is manual handling of the loads. Publication series of the Federal Institute for occupational safety and health medicine; Research report FB 897. Economics Publisher NW. Publisher of new science, Bremerhaven 2000

[13] Charastatic method for the assessment of the pull and push Publisher. Federal Institution for Occupational Safety and Health Medicine (BAuA), Dortmund. [http://www.baua.de/de/Themen-von-A-Z/Physische-](http://www.baua.de/de/Themen-von-A-Z/Physische-Belastung/Gefaehrdungsbeurteilung.html)

[Belastung/Gefaehrdungsbeurteilung.html](http://www.baua.de/de/Themen-von-A-Z/Physische-Belastung/Gefaehrdungsbeurteilung.html)

[14] Schaub, K.: Das „Automotive Assembly Worksheet“ (AAWS). In: Landau, K. (Publisher.): Configuration of the assembling process.  Case studies from ergonomics and organization. Ergonomia, Stuttgart 2004, S. 91-111

[15] Schaub, K.; Ghezel-Ahmadi, K.: From AAWS till EAWS – An expanded Screening- process for the physical stress. In society for the work- science e. V (Publisher.): Report till page 53. Work science congress from 28.2. Till 2.3.2007 at Otto-von-Guericke-Universität Magdeburg. GfA- Press, Dortmund 2007, S. 601-604

[16] Schaub, K.; Beck, M.; Frölich, W.; Gärtner, A.: Die Daimler Ergonomia Check- list.. In: Report till 54. Work science congress: Product and Productions Ergonomia – Task for the Development and Planning from 9 to 11.4.2008 at the Technical University of Munich. Published by: Confederation for work science e. V. (GfA). GfA-Press, Dortmund 2008, S. 629-632

[17] Schaub, K.; Storz, W.: The „New Production Worksheet“ – An example of applying Ergonomic EU-Directives. In: Proceedings of the Annual Spring Con- ference of the GfA on the Occasion of the 50th anniversary of the Foundation of the society for work science or ergonomics e. V. (GfA) and the XVII Annual Conference on the International Society for Occupational Ergonomics & Safety (ISOES), 7 to 9 May 2003 in Munich. Ergonomia, Stuttgart 2003, S. 327-330

[18] Find out the permissible limit values for the forces and torques. Publisher: Siemens AG. In house training material for the work structure, 1978

[19] Burandt, U.: Ergonomics for Design and Development. O. Schmidt, Köln 1978

[20] Schultetus, W.; Lange, W.; Doerken, W. (Publisher.) Assembly arrangement.: Data, Hints and Examples of the ergonomic work structure TÜV Rheinland,

Köln 1987

[21] REFA. Methodology of the organization. Work structure in the production unit. Hanser, München 1993.

[22] Handbook of the work structure and of the work organization. VDI Publisher Düssel dorf 1980

[23] Bollinger, H.-J.; Ilg, R.; Schmauder, M.: Ergonomics – Product- und Work place Design or structure. Täubner, Stuttgart 1994.

[24] DIN EN 1005-3: Safety while dealing with machines – Human physical

performance. Recommended force limits when operating machinery. Beuth,   
 Berlin 2002

[25] Europe from 12 – Empowerment of the work force. Publisher: Federal Statistical Office of Germany, Wiesbaden 1993

[26] DIN 33411-5: Physical strength of the men- maximum statistic action force

Count (11/99). Beuth, Berlin 1999

[27] Rohmert, W.; Berg, K.; Bruder, R.; Schaub, K.: Force Atlas; Data analysis of static action forces, Section 1-3. Publication series of the Federal institute for work -medicine. Economic publishing house NW Publisher for new science, Bremerhaven 1994

[28] Rohmert, W.: Static support work of the people: with tables for determining the recovery surcharge. Association for work studies REFA, Darmstadt 1960

[29] Physical strength of men: Isometric percentile of the maximum force as also the stamina and stress during concentric and eccentric muscle work. In: Rühmann, H.; Schmidtke, H. (Publisher): Colloquium of the Department for Ergonomics from the Technichal University of München for the HdA project "body forces of men part II”. O. Schmidt, Köln 1992

[30] Rohmert, W.; Rückert, A.; Schaub, K.: Body forces of men. Institute for the work science Darmstadt 1992.

[31] REFA. Methodology of the operating organization. Fundamentals of workplace design. Hanser, München 1993.

[32] Guiding method on the assessment: Assessment during Lifting, Supporting and Carrying. Publisher: Institution for the occupational safety and health medicine. (BAuA), Dortmund. <http://www.rueckenkompass.de/cd/doc/lmm-ht.pdf>

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