vhp human performance b.v.
Huijgensstraat 13a
2515 BD La Haye/Pays Bas
T +31 (0)70 - 38 92 010
F +31 (0)70 - 38 92 413
info@vhphp.nl
www.vhphp.nl

IBAN NL27ABNA0486072894
BIC ABNANL2A
KVK Haaglanden nr. 27259365
BTW NL8121.45.471.B01

Ergonomics approved quality label

Industrial torQtool 2

Date
01-11-2022

Author
Kees Peereboom MSc

Client
IDD-Parts BV
Marchandweg 23
3771 ML Barneveld/NL
www.iddparts.eu

vhp project number
000937

1 Introduction

This report contains a vhp quality mark assessment concerning the idd parts Industrial torQtool 2. This tool is patented as: Upgraded torsion spring tensioning tool / Reference: PA-600-0678.SE / Application Number: 2030352-5 and Swedish patent application 2230315-0 / 29 September 2022 / TORSION SPRING TENSION TOOL.

The assessment has been conducted in two ways:
1. Assessment of the use of the Industrial torQtool 2 concerning physical strain and occupational safety;
2. Comparison of the Industrial torQtool 2 method for these matters with the traditional method of clamping by hand with tensioning irons.

In the assessment for the vhp approved quality label, working conditions and ergonomics, the functional and user aspects of the product are assessed for compliance with the guidelines for physical strain and occupational safety. Concerning physical strain, the Dutch Physical Work Load Handbook and the BIM of the Dutch Labour Inspectorate (I SZW) have been used as a reference criterion, especially reference has been made to European standards of the NEN-CEN 1005 series.
Occupational safety aspects have been inventoried on the basis of the EU Work Equipment Directive. The Kinney & Wiruth method has been applied for this. Safety aspects in this assessment concern solely the assessment of safety with regard to occupational working conditions of users and do not imply the assessment of mechanical aspects of the tool itself.

This assessment was conducted under the auspices of vhp human performance by:
- Kees Peereboom, MSc, ergonomist, physiotherapist, movement scientist, Work and Organisation psychologist;
- The Kinney & Wiruth method has been applied as this has been recommended by Dr Wim van Alphen, Higher Safety Expert (HVK) [1].

2 Characteristics of manual traditional tensioning of springs for overhead doors

When installing and/or maintaining overhead doors, two springs must be tensioned per overhead door in case a new door is installed. Traditionally, tensioning is carried out by manually tensioning the spring with a tensioning iron (rod). With one hand the spring is tensioned haul by haul, while with the other hand it is ensured that the spring remains tensioned at all times (Figure 1). After the spring has been tensioned, the spring needs to be secured. These are three typical situations that might occur on a working day:
1. A mechanic installs one overhead door and needs to tension 2 springs;
2. A mechanic installs two overhead doors and needs to tension 4 springs;
3. A mechanic performs maintenance and must "re-tension" an already installed spring.

It needs to be noted that manual tensioning of the spring takes place in a consecutive nonstop manner, one needs to apply force/tension on the spring during the whole process of tensioning. A trained mechanic performs a haul every 4 seconds. A mechanic performs about 16 hauls 90 degree hauls per minute. Each spring requires a mechanic to perform a total of 14 360 degree turnings in less than 4 minutes. With some repacking and possibly a short rest moment, this can take a little longer.
The tensioning of the springs takes place after an overhead door has been mounted. All tensioning actions must be carried out immediately afterwards. This work therefore cannot be spread out over the working day. All in all, a mechanic will spend less than an hour working time per day on tensioning 4 springs.

[1] https://www.imaonline.nl/sites/default/files/faq/files/wegingsmethodiek-van-kinneyw.pdf (in Dutch)
Source: Kinney, G.F. and Wiruth, A.D. (1976), Practical Risk Analysis for Safety Management. Technical Publication 5865, Naval Weapons Center, California.

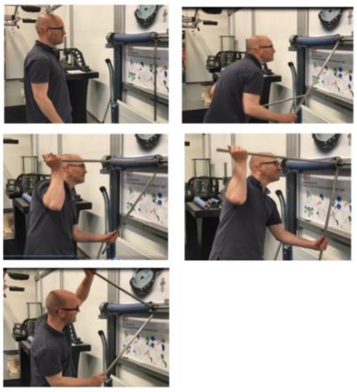


Figure 1 Left: Manual tensioning of an overhead door spring. Right: detail on working with bars/rods.

When manually tensioning overhead doors springs, data shown in table 1 are considered appropriate (source: iddparts nl):

Number of springs to be tensioned per day [2]:	***Total number of hauls per day to be made by the mechanic :***	***Actions needed in order to keep the spring tightened / fixate with the other non-hauling hand:***
2 / when mounting one overhead door	• An average of 14 revolutions results in 56 hauls per spring • Calculation: 2 springs x 14 revolutions x 4 quarter hauls per haul results in a total of 112 turns • Linear average force 210 NM up to a maximum force of 325 Nm per spring[3]	112
4 / when mounting two overhead doors	• An average of 14 revolutions results in 56 hauls per spring • Calculation: 2 springs x 14 revolutions x 4 quarter hauls per haul results in a total of 112 turns • Linear average force 210 NM up to a maximum force of 325 Nm per spring	224

Table 1. Data related to tensioning springs

[2] One overhead door with 2 springs is the minimum number a technician handles on a working day. During maintenance, springs must also be tensioned afterwards, this is not included in the equation.

[3] 1 Newton meter = 0.102 Kilogram-force meter, 325 Nm is equivalent to 33,15 kilograms

3 Features using the Industrial torQtool 2

The Industrial torQtool 2 makes working with tensioning rods/irons unnecessary. After applying the Industrial torQtool 2 tool, the spring can be tensioned using a drill (Figure 2).

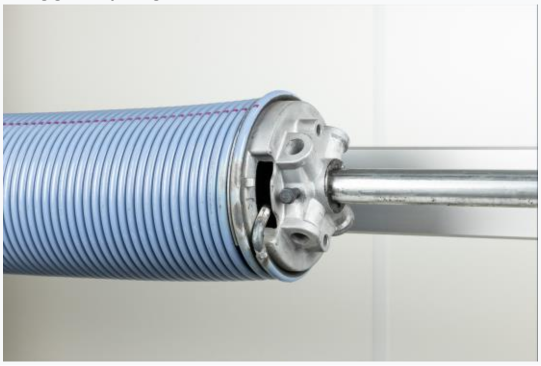
Figure 2 Application of the Industrial torQtool 2 using a drill: the spring is tensioned by the drill bit drive and not by manual force.

While applying the Industrial torQtool 2, the following relevant characteristics must be taken into account:

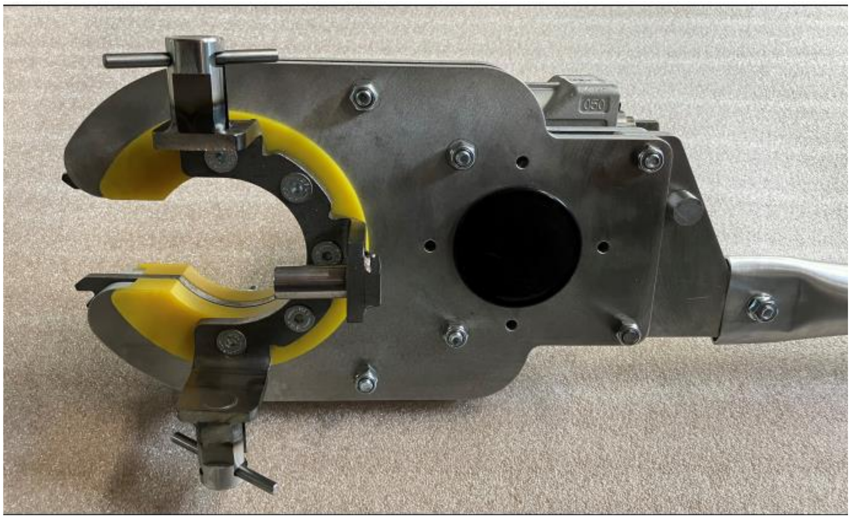
1. Read the operating instructions using the idd parts supplied PHOTO MANUAL (dated 04-02-2021) before use. Read this PDF. The MANUAL is a 10 page photo overview that shows each action separately. In this report the main steps are shown.

2. Install the torQtool 2 (via fixed pin and two spring pins) (Note: always work from a height adjustable platform, do not use a ladder. This due to safety requirements).

Plugged spring on an axis.



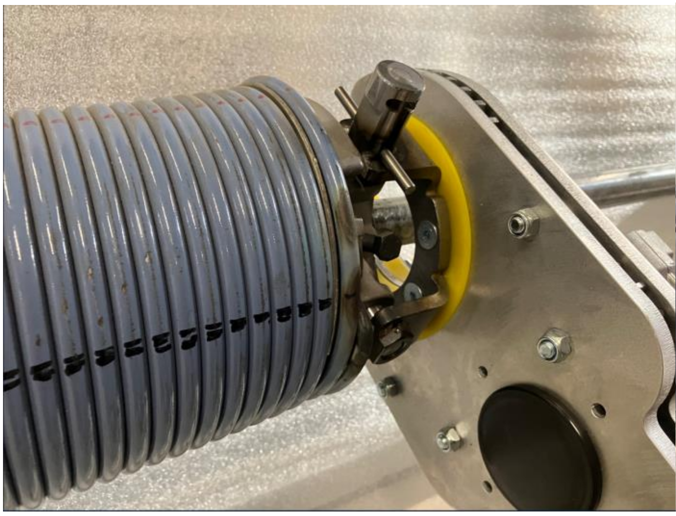
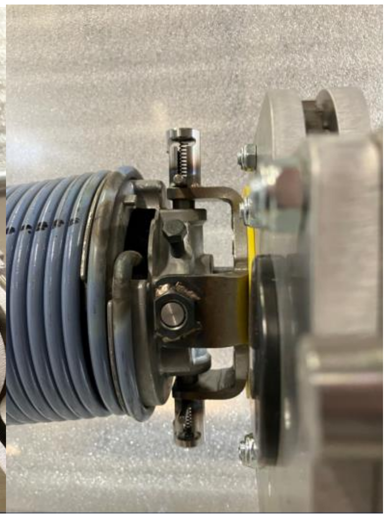
1. Blocking the two spring-loaded pins. Correct position of slot to torQtool 2 over axis.



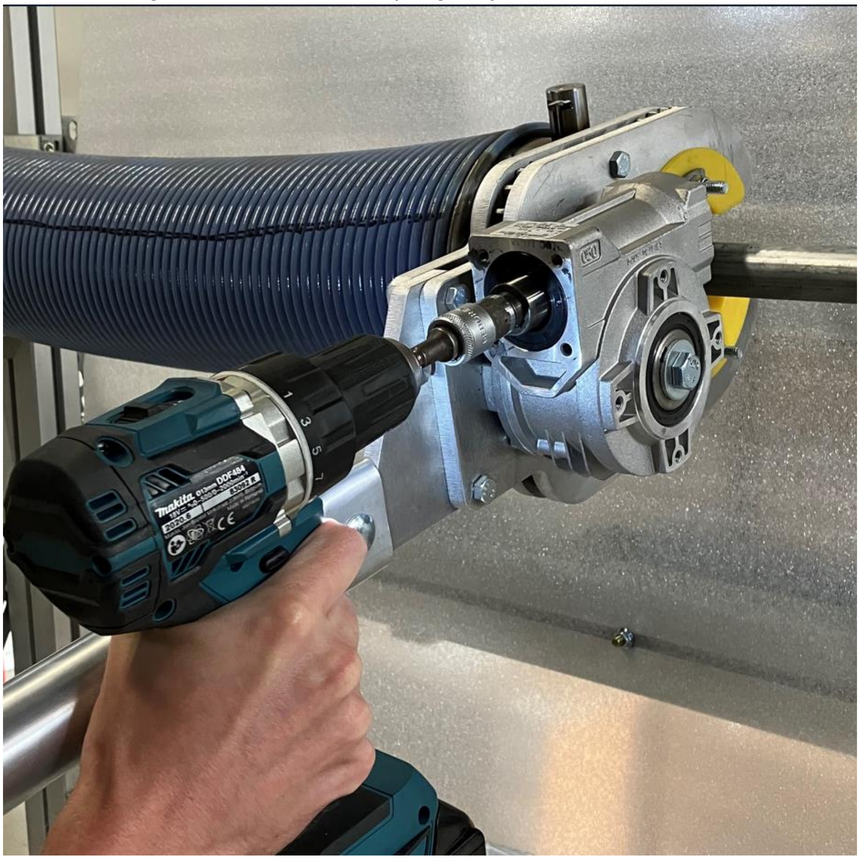
2. Bring torQtool 2 into position and make sure the fixed pin drops in the plug.

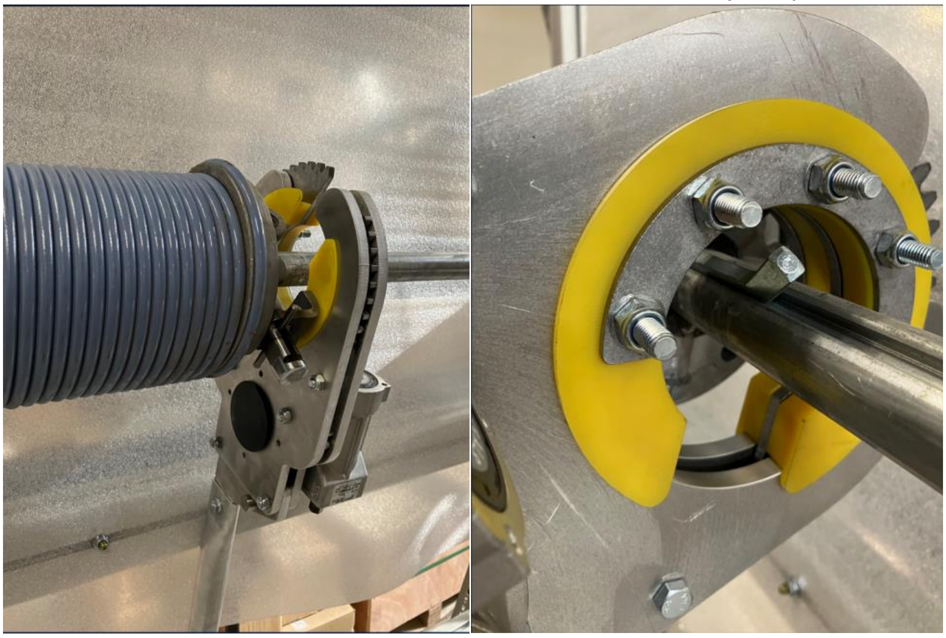
3. Pins are held in position by spring (2 times)

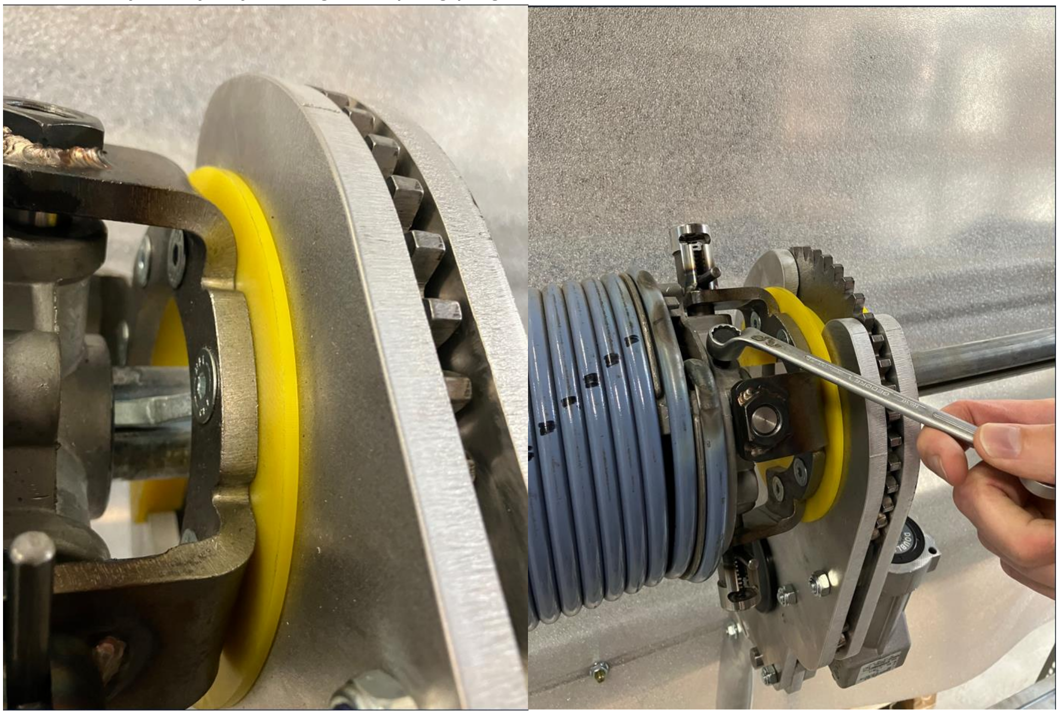
4. Using the drill, tension the spring. Pay attention to the direction of rotation.



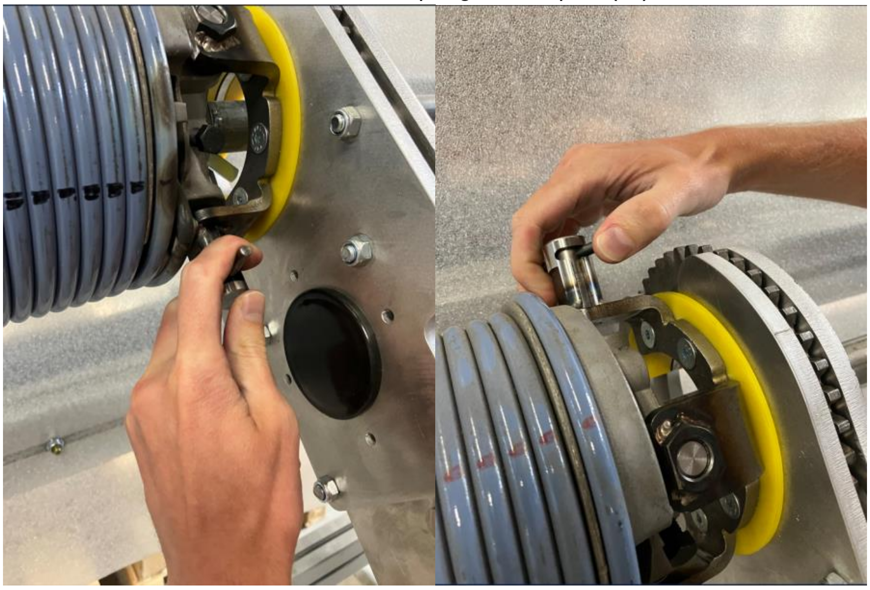
5. When the correct number of turns is achieved, move the key into position.



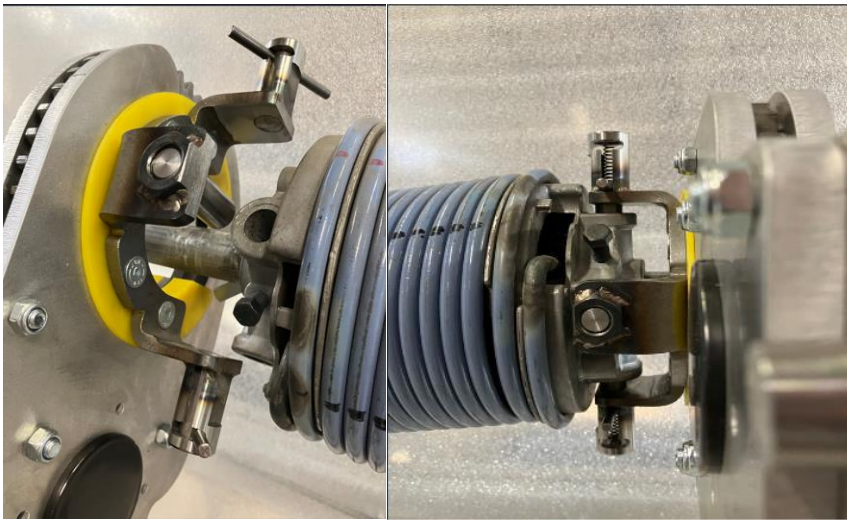
6. Key in keyway and tighten spring plug bolts



7. The handle is free. Then the spring-loaded pins (2x) can be unlocked.



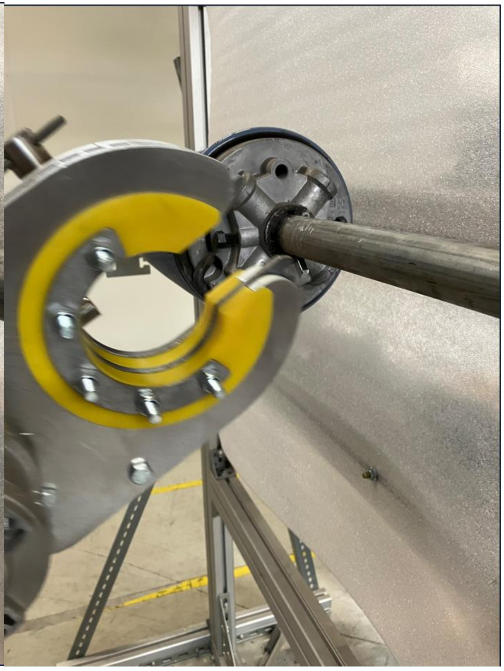
8. Remove torQtool 2 with fixed pin from plug and advance.



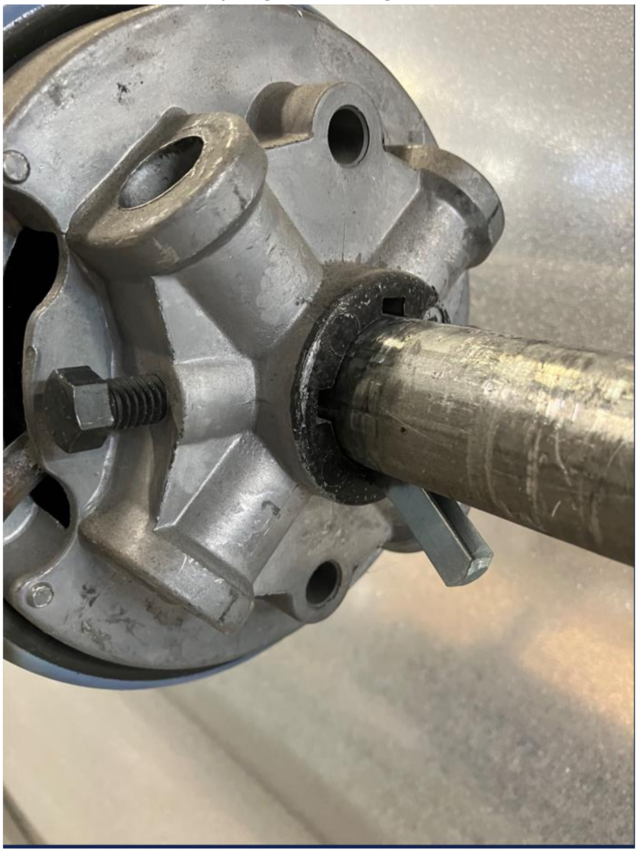
9. To remove torQtool 2, it must be twisted using the drill. Be sure to hold torQtool 2 securely.

Slot should be in line with the handle.

10. Remove torQtool 2.



11. Stretched spring: with wedge and 2 set crews.



4 Applied standards

Physical strain[4]:

- NEN-EN 1005-2:2003+A1:2008 Safety of machinery - Human physical performance - Part 2: Manual handling of machinery and component parts of machinery;
- NEN-EN 1005-3:2002+A1:2008 Safety of machinery - Human physical performance - Part 3: Recommended force limits for machinery operation;
- NEN-EN 1005-4:2005+A1:2008 Safety of machinery - Human physical performance - Part 4: Evaluation of working postures and movements in relation to machinery;
- NEN-EN 1005-5:2007 Safety of machinery - Human physical performance - Part 5: Risk assessment for repetitive handling at high frequency;
- NIOSH guidelines applied through 3D SSPP software that predicts static strength requirements for tasks such as lifts, presses, pushes, and pulls. The program provides an approximate job simulation that includes posture data, force parameters and male/ female anthropometry. Output includes the percentage of men and women who have the strength to perform the described job, spinal compression forces, and data comparisons to. The user can analyse torso twists and bends and make complex hand force entries. Analysis is aided by an automatic posture generation feature and three-dimensional human graphic illustrations. Developed by the Massachusetts Institute of technology (MIT) / USA[5].

Occupational safety

- NEN-EN 1050:1997 Safety of machinery - Principles for risk assessment;
- Directive 2009/104/EC — minimum safety and health requirements for the use of work equipment by workers at work;
- Kinney and Wiruth risk assessment ranking method [6].

Sustainable employability[7]

The application of the Industrial torQtool 2 significantly reduces the physical load of tensioning springs compared to the traditional approach of working with tensioning bars/rods. This is important if employers want to be able to continue to deploy their staff effectively up to a retirement age of 67.
Two issues play an important role in this.

- The first issue is the decrease in physical strength with age. Aging has consequences for the physical capacities of employees. In general, the highest physical resilience of people is reached between the ages of 20 and 30. After that, the taxability decreases by an average of one percent per year. This is shown in the figure below. The maximum force to be delivered by an average person of 65 years is 40% lower compared to an average person of 25 years. This means that, over the years, the same work becomes heavier due to the advancement of age and the decrease in taxability which occurs at the same time.

[4] https://www.inspectieszw.nl/publicaties/richtlijnen/2015/06/15/bim-fysieke-belasting-checklist-fysieke-belasting

[5] https://c4e.engin.umich.edu/tools-services/3dsspp-software/3dsspp-references/

[6] https://www.imaonline.nl/sites/default/files/faq/files/wegingsmethodiek-van-kinneyw.pdf

[7] NEN NPR6070 managing Sustainable Employability.

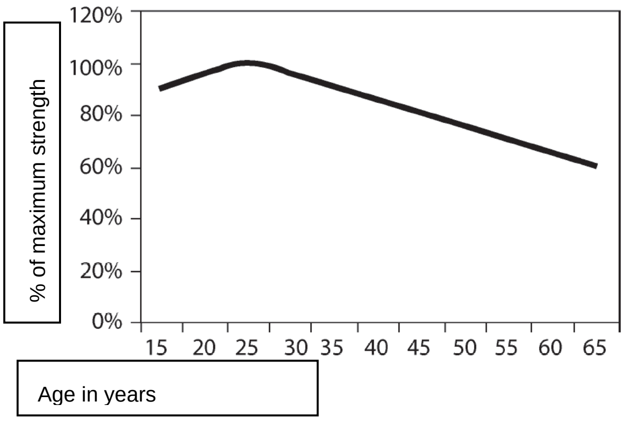


Figure 3 Maximum applicable force related to age (From: Zwart, B.H.C. de, Duurzame Inzetbaarheid van oudere werknemers (Sustainable employability of older workers, SDU publishers 2011, Netherlands).

- The second factor that is of influence is the fact that exposure to stressful circumstances for years increases the chance of developing musculoskeletal complaints. This leads to pain, discomfort and wear and tear and can ultimately lead to absenteeism and absenteeism from work. The Dutch Health Council has conducted extensive research concerning the consequences of applying force, pushing and pulling at work. Effects were mainly found in the form of lower back pain and shoulder complaints. A general conclusion is that about a quarter of regularly exposed workers develop chronic complaints that lead to adverse health effects. The table below shows the most important results of a large-scale and systematic literature study into the development of health complaints as a result of applying force and pushing and pulling.

Table 2 shows the exposure-response relationship found in research literature that has been published by the Dutch Health Council concerning back complaints and shoulder complaints as a result of applying force through pushing and pulling in work situations. ODDS ratio means: % of complaints in relation to other workers who have not been exposed to the load by applying force, pushing and pulling.

Exposure	***ODDS ratio back complaints compared to workers with no exposure***	***ODDS ratio shoulder complaints compared to workers with no exposure***
Exposure to pushing, pulling and / or carrying several times a week between 1 and 20 years	+10%	Not available
Exposure to pushing, pulling 135 x a day and/or at least: 22,4 minutes a day	+20 up to + 50%	+90% up to + 290%
Exposure to pushing, pulling 741 x a day and/or at least: 69 minutes a day	+20% up to+ 70%	+130% up to + 490%
Exposure to pulling over 25 KG/Force (Indication of pulling at least during 50% of an average working day)	+40%	+80%

Table 2 ODDS ratios in %

5 Review

The assessment has been performed per type of task. The assessment only concerns the tensioning of springs and no other activities (see Appendix section 7.2 for an explanation). Where relevant, a distinction is made between one overhead door (tensioning 2 springs) and two overhead doors (tensioning 4 springs).

Issue:	***Working with bars/rods:***		***Applying the Industrial torQtool 2:***
Working postures	**No risk**		**No risk**
Repetitive movements	**Risk**	**Risk**	**No risk**
Force applied through pushing and/or pulling	By using 3DSSPS MIT biomechanic computer model		**No risk**
	2 springs	***4 springs***	
Outcome per body segment:	**Wrist: 71% population is at risk**	**Wrist: 78% population is at risk**	**No risk**
	Elbow: 46% population is at risk	**Elbow: 51% population is at risk**	
	Shoulder: 41% population is at risk	**Shoulder: 45% population is at risk**	

Table 3 Physical Workload risk assessment

Occupational safety

When manually tensioning with tensioning bars/rods, there is a risk that tensioning irons will come loose and injure the user / mechanic. This occurs regularly in practice. After all, the mechanic must always keep the spring tensioned with manual force (one hand) and in the meantime change the position of the bars/rods (with the other hand). This risk is not present when using the Industrial torQtool 2.
The following safety safeguards are built in when using the Industrial torQtool 2:

- Tensioning bars/rods are not in use. Therefore, no significant arm force is supplied, this avoids the risk of parts coming loose.
- During fitting the gear wheel is blocked in 3 positions (2x with a spring plug and once with a fixed pin);
- Application of a gear lock with a locking piece is mandatory, the tool can only be closed if all parts are in the correct position. The Industrial torQtool 2 can only be operated when the telescopic handle has secured the strike plate.

Issue:	*Working with bars/rods:*		*Applying the Industrial torQtool 2:*
	2 springs	***4 springs***	***2 and 4 springs***
Probability occurrence of an occupational risk	6	6	1
Exposure factor	6	6	6
Severity health effect when risk occurs	3	3	1
Score/ risk index	**108** **Important risk**	**108** **Important risk**	6 **Slight risk**

Table 4 Occupational Safety risk assessment with the Kinney & Wiruth method (see Appendix section 7.1 for an explanation)

6 Ergonomics approved quality label

The iddparts nl / Industrial torQtool 2 has been approved of and is provided with the vhp quality label for ergonomics and occupational safety.

The iddparts nl / Industrial torQtool 2 makes it possible to tension springs for overhead doors in the field of physical workload (without risk) and occupational safety (low risk). This has been tested according to relevant EU and worldwide (NIOSH) standards and regulations.

The iddparts nl / Industrial torQtool 2 contributes to the sustainable employability of overhead door fitters / mechanics.

The iddparts nl / Industrial torQtool 2 offers a considerably safer and physically less stressful method compared to the traditional method of manual clamping with tensioning bars/rods.

The quality label is valid for 5 years. If adjustments are made to the iddparts nl / Industrial TorQtool 2, the research and testing works must be carried out again.

The following preconditions for use apply:

- Read the manual before use and apply the Industrial torQtool 2 as described in this document.
- Always work from a height adjustable platform and never from a ladder. A ladder is used to move up and down and is not considered a workplace.

7 Appendixes

7.1 Kinney & Wiruth method

With this method for each risk three parameters have to be determined:
- Severity of injury linked to hazard (S);
- Exposure to the hazard (E);
- Probability of the hazard to occur when exposed (P).

These concepts are made operational so that it becomes a numerical method and a quantitative risk estimation can be made.

Probability
The probability or (mathematical) chance an incident will occur. The expectation is represented by ascribing a value from 0.1 to 10.

P Probability
0,1 Next to impossible / unthinkable
0,2 Almost unimaginable
0,5 Highly unlikely, but conceivable
1 Unlikely, but possible in the long term
3 Unusual (but possible)
6 Possible
10 To be expected

Exposure
The factor exposure indicates the duration that a risk can occur. The scale varies from 0.5 to 10.

E Exposure
0,5 Very rarely (less than 1x a year)
1 Rarely (approx. 1x a year)
2 Sometimes (approx.. 1x a year)
3 Occasionally (weekly)
6 Frequently (daily)
10 Constantly (multiple times a day)

Severity
The factor severity indicates the possible damage, effects and consequences linked to a hazard. The scale reaches from 1 to 40.

S Severity
1 Slight effect, injury without absence through illness
3 Important, injury with absence
7 Severe, lasting injury with absence
15 Very severe, a fatal casualty
40 Disaster, multiple fatal casualties

Risk-index
The result of multiplying the parameters defines the risk-index: R = S x E x P. The risk-index has five categories. Based on this risk-index the appropriate (technical) measures can be determined. Eliminate or reduce risks as far as possible (inherently safe machinery design and construction).

Classification Risk-index Risk and measures
1 R = 21 Slight risk; acceptable
2 21 < R = 71 Little risk; attention required
3 71 < R = 201 Moderate risk; apply simple measures
4 20 < R = 401 High risk; apply large measures immediately
5 R > 401 Risk is too high; stop activities / operations

7.2 Assessment physical workload

Working postures

The shoulder / arm position is particularly important. Because the movement takes place 112 (with 2 springs) or 224 times (with 4 springs) times on a working day, this is not a bottleneck in terms of working posture but this is primarily related to Repeated operations with high frequency.

The method called OCRA from NEN 1005-4 has been applied here. In short, the method assesses:

- Posture and movement (0.7)
- Repetition (0.7)
- Additional factors (including vibrations, cold, noise, working with gloves on) (1)
- Force (0.2)
- Recovery period (1)
- Working time (2)

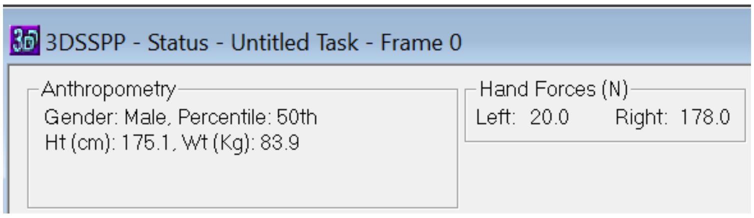
A formula is filled in based on each of these factors. The outcome leads to an index number that indicates the degree of risk (no risk / low risk / high risk). The scores per issue for working with tensioning bars/rods are shown in brackets: The formula is now 30 x 0.7 x 0.7 x 1x 0.2 x 1 x 2 = 5.88. Score> 3.5 = risk.

Use of force through pushing and pulling

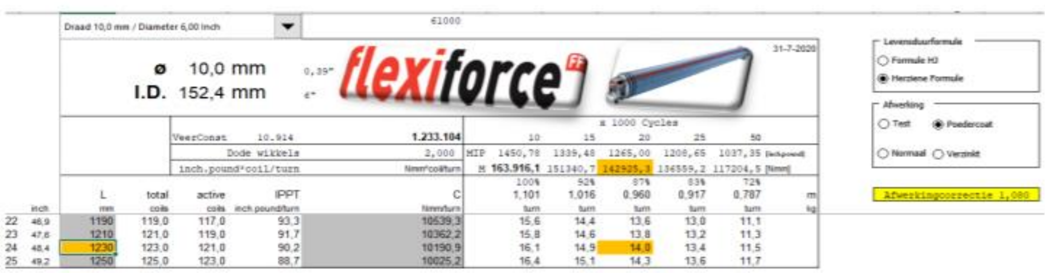
The 1005-3 standard focuses in particular on forces that are supplied while the body is supported (eg when sitting). This is not the case when working with tensioning irons. This standard cannot be properly applied. However, the Chaffin method based on NIOSH standards are well applicable and have been used for this.

Chaffin method biomechanical calculation model based on NIOSH standards

There are several types of springs and the required arm force differs per haul (if the spring is more tensioned, more force is needed for the next haul). Because it concerns a principle comparison between working with tensioning irons and not working with tensioning irons, one situation has been introduced in Chaffin. Chaffin indicates per body segment which% of the mechanics can do this without the risk of complaints (Strength % Capable).



The starting point is: man, average height, weight approx. 84 kg.



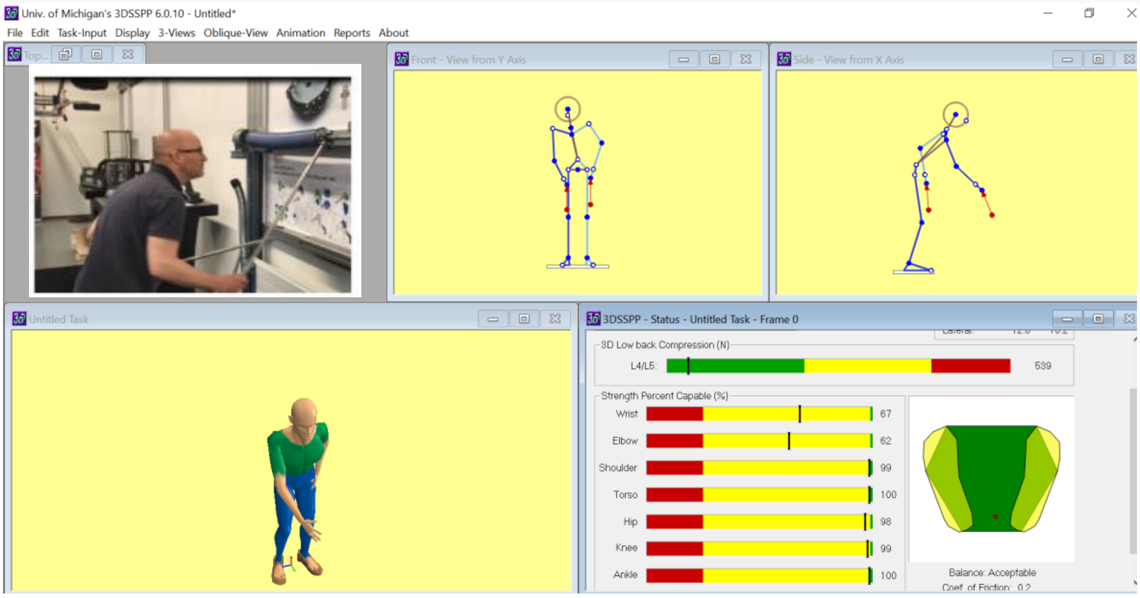
The following representative situations were selected as the starting point for the evaluation:

- With 2 springs: 14 revolutions per spring (see orange field in figure with 14), that is a total of 56 hauls per spring, that is 112 hauls per day.
- With 4 springs: 14 revolutions per spring (see orange field in figure with 14), a mechanic makes 4 hauls per revolution, that is 224 hauls per day.
- A lever / tensioning bar / rod length of 0.8 meters (142.92 N in the above figure times 1.2 is based on 1 m and this has been converted to 0.8 m, the result is 178.65 N) .

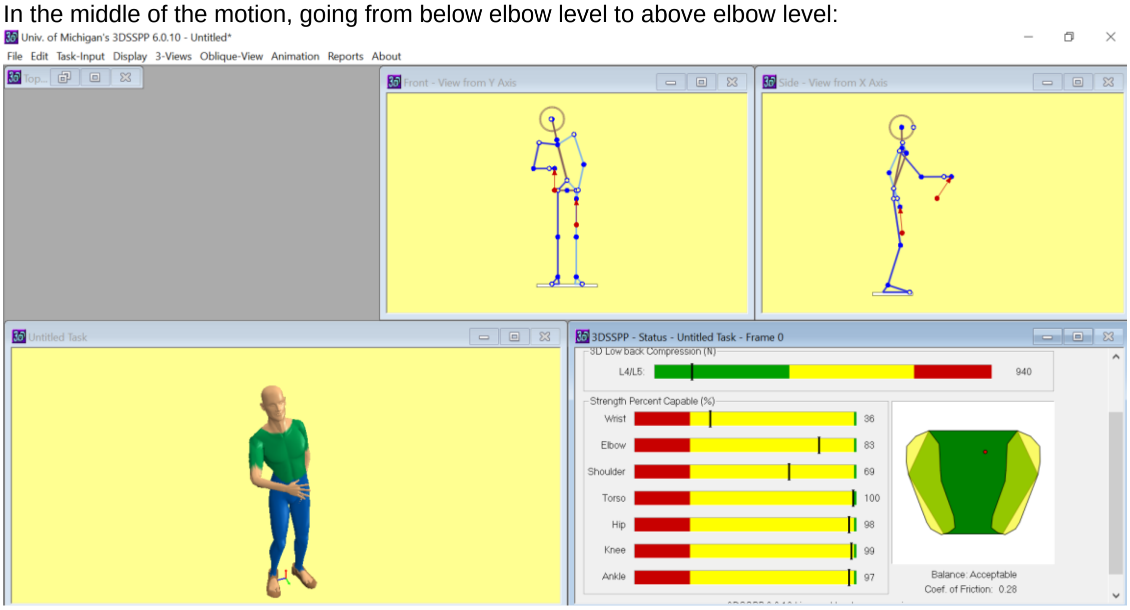
Chaffin calculates the power supplied by the mechanic once (per day). This while in practice an average of 112 or 224 times a day this force is applied. The French industry standard AFNOR NF X 35-106 was used to convert from 1x to 112 and 224 times a day. This standard indicates that when pulling up with one arm, the difference in acceptable load between performing the action once and performing the same action 112 times per hour is approximately 20%. At 224 times per hour, the correction should be about 30%. The result is that the values found on the basis of a once a day movement have been corrected for this.

Because the position of the shoulder joint is particularly important, a determination has been made of the beginning, the middle and the end of the movement. The location of structures and muscles around the shoulder joint indicate that the transition from "below the elbow" to "above the elbow" is particularly stressful, the results confirm this. Because the spring tension arm (and not the fixation arm) is the limiting factor, the assessment focuses on the spring tension arm.

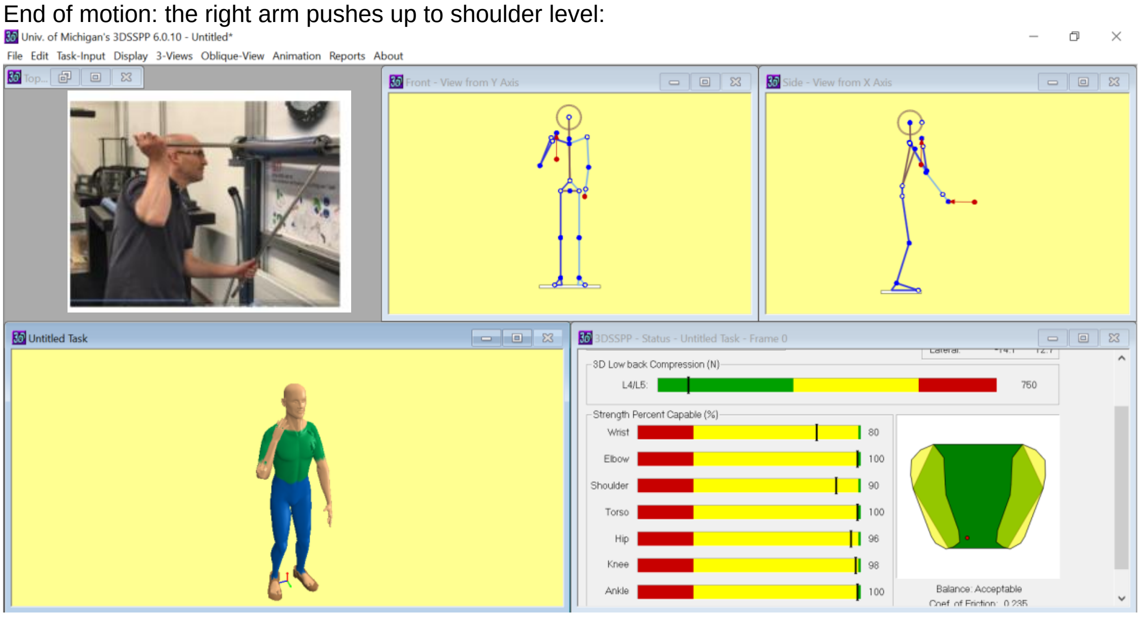
Start of the spring tensioning movement: starting the tensioning movement from the lower arm:



In the middle of the motion, going from below elbow level to above elbow level:



End of motion: the right arm pushes up to shoulder level:



The outcome of the force indicated by the Chaffin application is increased by 20% (for 112 times) and 30% (for 224 times) because of the frequency factor (This is not done related to once a day but to 112 or 224 times in one hour). Because Chaffin assumes Strength% Capable, i.e. part of the population that can do this without problems, the result is reversed: we focus on the part of the population (as%) that may have a chance of developing physical complaints due to this work.

Final comments:

- It is likely that in practice peak forces are delivered in difficult situations / postures. The load in these types of situations is very likely to be higher. Research has shown that in such situations the principle of mass inertia / acceleration is of great influence. idd parts has performed push / pull measurements in controlled lab situations. In practice, the actual forces are often higher. This is important for two reasons: First: The force is higher in practice than the force that is strictly required and that is measured in a lab set-up, this results an underestimation of the risk. Second: Especially people who are smaller, who are less strong and / or who have less mass / weight, these people are more using peak force to be able to do this work, so for them the load is disproportionately higher. This is also because their load-bearing capacity is already lower on average.

- The frequency is converted into the average number of actions per hour. In practice, however, a spring is tensioned contiguously, so the movements / the application of force follow each other immediately without resting moments, this has a loading effect. This effect has not been incorporated in the available standards.
- Because the shoulder joint is much more complicated than the wrist and elbow, complaints are more likely to arise there. The Chaffin model is primarily based on the capacity of muscles to deliver force and not primarily on vulnerable structures around the joints, especially the shoulder joint.
- Supplying force by pushing and pulling is the key issue. We also looked at how the Dutch labour Inspectorate assesses this. However, they uses a method that is primarily intended for working with wheeled containers and is therefore not suitable for assessing this work[8].

[8] https://www.inspectieszw.nl/publicaties/richtlijnen/2012/06/15/bim-fysieke-belasting-duwen-en-trekken