

QUALITY CHARTER



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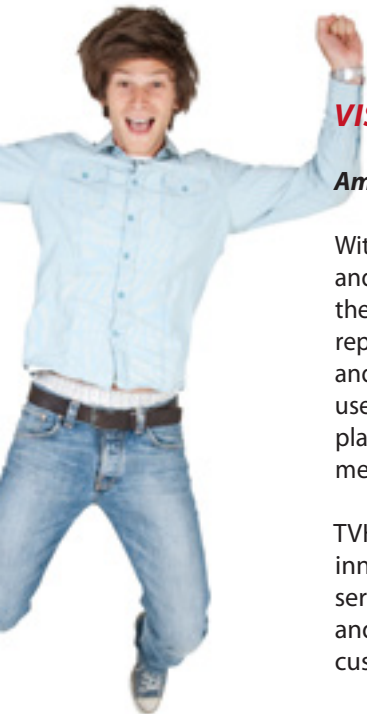
TOTALSOURCE[®]

TVH

CUS



IS INNOVATIVE AMBITIOUS AND FOCUSED ON CUSTOMER DELIGHT



VISION

Ambition / Leadership / Innovation / Customer Delight

With a work force of over 2400 people and subsidiaries in all continents, TVH is the ambitious worldwide market leader in replacement parts for material handling and in-plant industrial vehicles, new and used lift trucks, new and used aerial work platforms and internal handling equipment.

TVH sets the benchmark for continuous innovation and excellence in quality and service in this segment of the industry and remains fully focused on delighting customers and stakeholders.

TVH is committed to providing a true One-Stop Shop experience and continually

strives for operational excellence through innovative business practices and never-ending measured improvements.

TVH is committed to fostering a challenging and rewarding environment for its employees who keep in mind teamwork, growth & development, creativity and initiative.

Everyone within the organisation, regardless of nationality, religion, culture or background, supports this mission and these values.

COLLABORATING WITH TVH = 30 EXPECTATION FILLED

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- TVH is a supplier of after-market spare parts and accessories that are fitted for OEM-equipment. OEM references and brands are purely indicative and do not imply that the accessories and/or spare parts are coming from the original equipment or parts manufacturer.
- Products that do not comply with regulatory requirements concerning CE conformity are not placed on the market in the European Economic Area.
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1. PRODUCT

1.1. Stock items

We have a permanent stock of 450 000 items.

We strive for being a one-stop shop for all spare parts, accessories and tools the customer may need for the maintenance and repair of all his machines. Whether it's a fork lift truck, an in-plant vehicle, an aerial platform, a telescopic fork lift truck, a sweeper or any other internal transportation device. We have a permanent stock of 450 000 spare parts for more than 250 brands, irrespective of the age and origin of the machine.

We can offer common and less common spare parts for 250 different brands.

Since TVH wants to be a one-stop shop for our customers, it maintains an extensive stock of spare parts for different brands (not only fork lift related brands but also makes for in-plant vehicles, aerial platforms, telescopic fork lifts, etc)



1.2. Product responsables

Should the customer have any questions regarding a particular spare part, he can expect us to give him a thorough, detailed and professional answer. Our more than **65** product responsables representing over **580** years of combined experience along with our extensive range of test equipment, enables us to guarantee a correct interpretation of all technical questions.

Furthermore, we have at our disposal a wide range of test devices by means of which we can conduct precise and strict quality controls:

- Flow meter
- Hydraulic cylinder test bank
- Hydraulic valve test bank
- Test bank for starters
- Surge tester
- Tester for electric motors
- Tester for batteries and chargers
- Test banks for transmissions
- Spectrometer
- Hardness tester – scleroscope
- Tester for springs/gas springs
- 3D measurement
- 3D measuring arm
- Test bank for injection pumps
- Electronics

Please find a complete overview of the available test equipment at the end of this brochure. (p22)

TVH is also aware of the profound benefits of training sessions and is convinced that well-trained employees will result in a high quality service. Therefore, TVH founded the TVH Training Centre, an internal, well-equipped and professional training centre which has been operative since April 2008.

A team of well-qualified trainers and instructors are keen on passing on their thorough knowledge in a wide range of competences to both internal employees and customers. The foundation of the Knowledge and Training Centre is a mere investment of TVH in the knowledge present amongst the company employees and in the many talents and skills of its employees and customers.

You can expect your technical questions to be processed by product responsables who are experts in their field.





You can count on your contact sales person, who is continuously supported by the product and brand responsables.

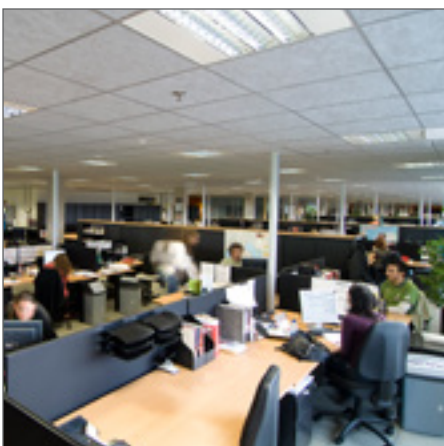
The TVH contact sales person, to whom the customer communicates price enquiries, orders and complaints, is continuously being supported by the product responsables and R&D Department. In this way, we manage to process the customer's information in an efficient way and pass it on to the technical department in order to quickly give him feed back on his questions.

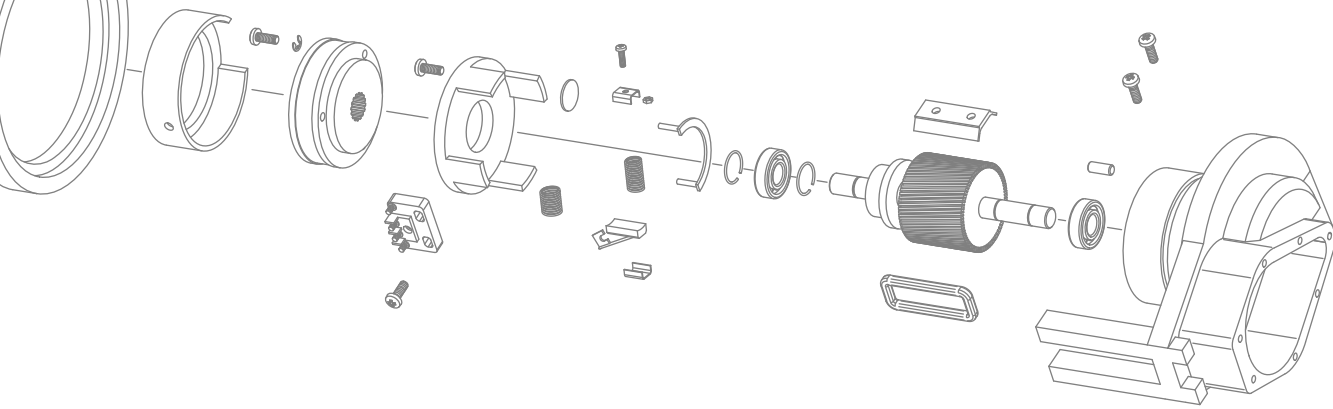
1.3. Identification of spare parts

Our technical department identifies parts for the most important lift truck and aerial platform brands.

An extensive team of more than 50 brand experts representing over 435 years of combined experience, are in charge of the correct identification of spare parts and part numbers for the customer's machines. On request, we can also provide the customer with technical information.

To do so, we turn to our technical library, which was set up in 1969 and currently contains more than 6000 technical reference books.





1.4. Free identification of spare parts

TVH offers the customer the technical service where we identify the spare parts for different types of machines (e.g. fork lift trucks, aerial platforms, telescopic fork lift trucks) free of charge.

Due to this service, the customer can always rely on us for a quick and complete identification of the spare parts needed. The customer himself can also identify spare parts in Quick Reference, which is part of our TVH Quick Source programme and copy the references found to a price inquiry or order (please view expectation n° 25).

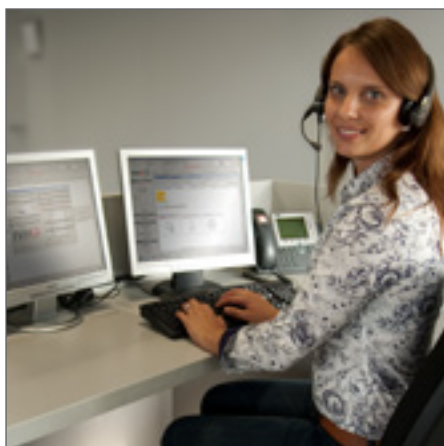
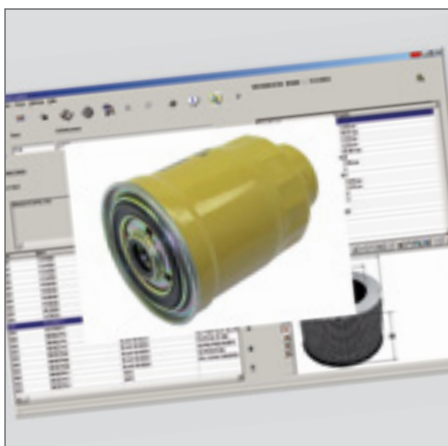
The identification of spare parts by our technical department is free of charge.

1.5. Technical sheet

Should the customer have any doubts about a particular spare part, he can consult its technical sheet or picture via TVH Quick Source or request this info with the contact person. This extra service gives him the opportunity to check in advance what he will be ordering, so as to reduce the risk of ordering the incorrect part in error.

Our internal sales staff are trained as well to identify any reference needed on the basis of the customer's technical data.

You can expect us to have a technical sheet and/or picture available for 95% of all spare parts we sell on a daily or weekly basis.



1.6. References

You can enquire for or order parts with lift truck brand, manufacturer's brand or TVH references. We possess a database consisting of 16 million different references.

To make the process of registering price enquiries and orders as easy as possible for the customer, TVH opted for a transparent system allowing him to make price quotations with any reference he may have at the time of the enquiry: our internal TVH-reference, the reference of the lift truck brand, and the one from the manufacturer's brand.

By means of this, we can guarantee the customer that we always strive for offering him an appropriate solution, irrespective of the type of information he has.

We offer you the possibility to enquire for or order spare parts with your own references.

To meet the customer's needs, we offer him the possibility to give us his own reference number – his own part number or warehouse location – so that we can print this info on our labels. This is a free service of TVH.

This extra service does not require him to maintain or update lists, and, what's more, it will save the customer time when the parts ordered have been delivered.

This service is immediately applicable and does not require an adaptation of either the customer's or our system.





1.7. Stock rupture

We consider it of paramount importance to help the customer out in any given circumstance. Therefore, we automatically offer him where possible, an alternative part if we for some reason cannot supply the requested part immediately.

In case of a stock rupture an alternative is automatically offered if available.

1.8. Warranty

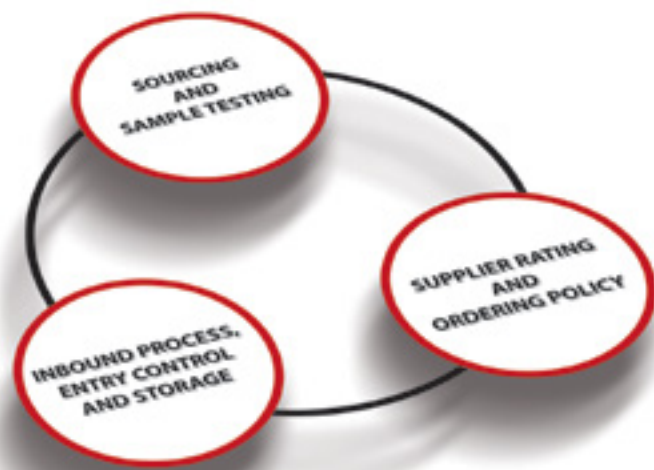
To be able to continuously offer the best quality products at a competitive price, with a 6 months warranty, TVH has put in place a rigorous policy, structure and process.

Sourcing and sample testing:

A specific team is sourcing all over the world for new suppliers and partners. They visit worldwide, automotive and material handling fairs to come into contact with the right suppliers for our niche market. The 'prospect vendors' are screened and asked to provide references and samples for quality checks. All samples we receive from our suppliers are subject to profound testing in our Quality Control Department. We have invested in top-quality testing and measuring devices, such as a hardness tester, spectrometer, 3D-measurements, PCB test equipment etc in order to measure, compare and test the samples (some of them may also be built in machines to allow testing in a real work environment).

All our products come with a warranty of minimum 6 months, unless otherwise specified on our offer and order confirmation.





Supplier rating and ordering policy:

Once a “prospect supplier” is approved, he becomes an actual suppliers. The product advisors take over the prospect accounts from the sourcing team after a first approved delivery.

On a regular basis an extensive system rates their performances:

- Product quality (equal to OEM in use, life cycle and dimensions, with warranty on all parts)
- Packaging of the goods supplied
- Overall supplier reliability (on-time deliveries, response time to our questions, pricing availability of the products,...)

Inbound process, entry control and storage

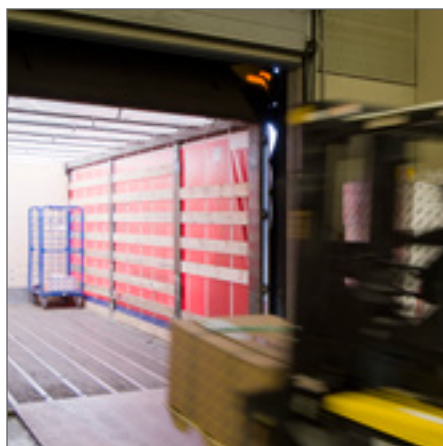
Inbound shipments are registered at the goods-in reception. Urgent deliveries are detected at this stage and are handled with priority. The unpacking department measures and tests the incoming parts, based on the information we have stored in our system in technical sheets, drawings, sample test reports and spec sheets of that specific part.

Random checks determine which parts per shipment will be tested. This way, we can check whether the shipment is in conformity with the received samples and in compliance with the agreements made with the supplier. These results are incorporated in the supplier rating system we have set up.

If the quality of the parts is approved, they get an internal code and label, are all individually packed and put in stock under excellent warehouse conditions (humidity, temperature,...). Packaging is assigned to each part individually taking in account price, volume and protection.

Presentation of the process

This repeating process is controlled by Key Performance Indicators (KPI's) and a Balanced Score Card (BSC), which determine possible adjustments and improvements where necessary.



2. ORDERS

TVH not only focuses on Product Quality but also considers a qualitative, adequate and professional service in general of paramount importance.

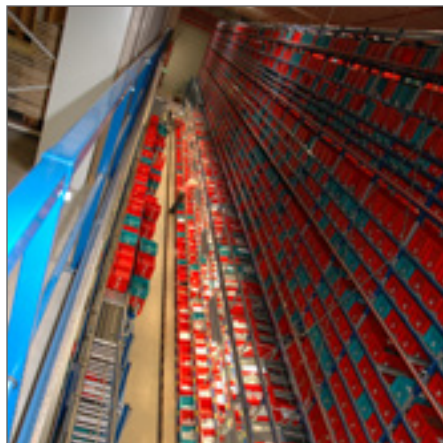
In this context, the Customer Delight Management project was introduced in the Sales Department and is applied daily to allow us to continuously improve and optimise our internal and external processes. As a result of those efforts we can guarantee the services mentioned below.

2.1. Check of every order

We aim for offering our customers the correct spare parts at the agreed time. Therefore, every order (whether it is placed by TVH Quick Source, by phone, by fax or by e-mail) is subject to a quality check by the customer's contact person.

Irregularities are identified by the computer system and then double checked by the TVH contact person. If necessary, the customer will be contacted by his contact person to discuss the abnormalities so that the order can be sent according to the customer's expectations and to avoid complaints or returns notes.

Every order you place, will be checked and confirmed by your TVH contact person in order to detect possible irregular order lines, and to double-check them with you.





2.2. Transportation

Normally TVH arranges the transport of the goods to your premises. In this case the transport cost will be calculated separately on your TVH invoice.

TVH offers the customer the possibility to arrange for the transportation himself or to use one of the carriers we have partnerships with. If the customer wishes to use one of the TVH carriers, we guarantee that the goods will be delivered to the customer's premises at the best rates and excellent transmit times. The transport fare will be calculated on the customer's invoice. For most of the neighbouring countries, TVH also offers night deliveries. Whenever there is a service problem with one of the shipments, a team of specialists is always at one's disposal. TVH applies a "multi-carrier strategy", when a customer is not satisfied with the service of a provider, he can switch to another. Opting for one of the TVH carriers will save the customer time as he will no longer have to pass the pick-up requests to the carrier. The carrier-code is automatically inserted in the order so that our dispatch department can sort the packages.

2.3. Back orders

Back orders are sent with next shipment by default. Consolidation is also possible. Orders are sent within 30 days for EU or 60 days for export countries.

TVH strives to offer the customer the lowest transport cost possible, also for backorders. Therefore, spare parts that are assembled in a backorder are always sent with the customer's next shipment, unless the customer specified differently in his communication to TVH.

TVH has also created the option to consolidate different back orders, which means that back orders are copied to the customer's new order and will be packed and sent with that new order. This reduces the number of boxes per order and the chance of losing a box/spare part during transportation. It also consolidates the transport costs.



2.4. Package

TVH assures that the goods are sent in an adequate, ecological packaging adapted to the size of the products and the means of transportation. In this way, TVH is able to reduce considerably the chance of damaging the goods during transport and to offer accurate transport costs. Moreover, we are able to reduce non-recyclable waste for the customer.

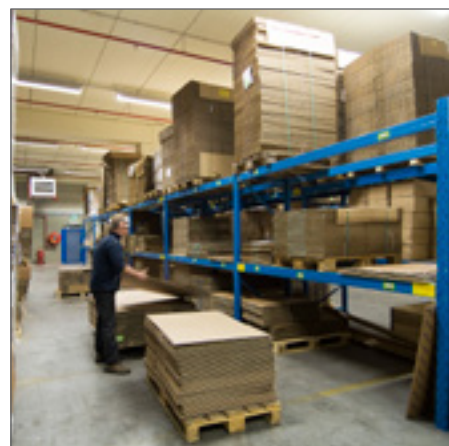
We ship our goods in a suitable packaging.

2.5. Advising customers if urgent orders cannot be sent in time

In co-operation with our Dispatch department, we have determined per country specific cut-off times for our carriers. This enables the customer to meticulously plan his orders. TVH guarantees the customers that the orders will be shipped the same day provided they were placed before cut-off time of a particular country and provided they contain maximum 40 order lines or 80 spare parts per order line.

We ship approximately 5500 orders per day worldwide by means of different carriers. 99,8% of the orders are delivered within the correct time interval. However, TVH is also subject to unplanned actions taken by third parties, bad weather conditions, failures in the information system etc. Therefore, if for some reason, the order(s) cannot be shipped at the time promised, we advise the customer by e-mail that same evening.

We guarantee that express orders placed before cut-off time, will be shipped the same day. Should the order not be sent for some reason, you will be notified.





TOTAL SOURCE®

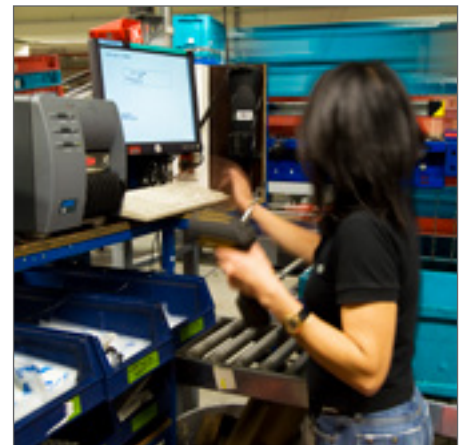
We want to provide the customer with the correct information as to enable him to inform his customer of possible delays and, if necessary, modify the daily plan.

2.6. Return of goods

***Parts that were
incorrectly supplied
by TVH can be
returned without
costs.***

Expectation n° 11 stresses that our spare parts have a warranty of 6 months, unless stated differently on the documents. TVH also assumes the responsibility if the return is the consequence of an error on behalf of TVH. If TVH delivers an incorrect part, then we will arrange the pickup of the incorrect part at no cost.

The TVH Sales and Purchase department verify in detail every complaint and take measures so as to correct possible mistakes, to improve the product quality etc in order to avoid similar problems in the future.





3. TVH QUICK SOURCE

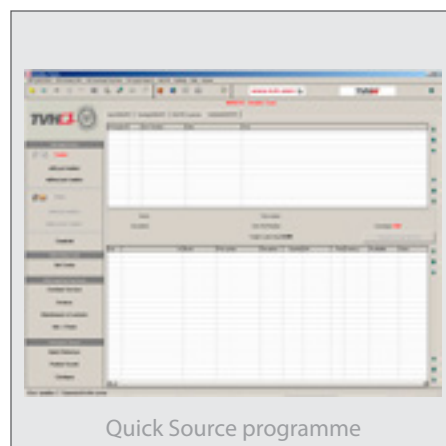
Although TVH is ready to serve the customers by means of their fixed contact persons, TVH Quick Source was developed to meet the needs of the customers by offering them the possibility to make price inquiries on-line, 24/7 or if the contact person should, for any reason, be unavailable.

We are working on a new interactive online webshop for spare parts, My TotalSource.

3.1. Availability

The programme, which is available 24/7, is continuously being updated with innovative applications to meet the ever increasing needs of the customers and to enable us to offer our customers a valuable and extensive service. The language barriers with our customers worldwide have been removed by designing the programme in 20 languages (Dutch, French, English, German, Spanish, Portuguese, Italian, Croatian, Lithuanian, Hungarian, Norwegian, Finnish, Danish, Swedish, Polish, Romanian, Czech, Slovenian, Turkish, Russian).

***TVH Quick Source
is available in
20 languages and can
be consulted 24/7.***



3.2. Benefits

***Our on-line program
TVH Quick Source
is available free
of charge.***

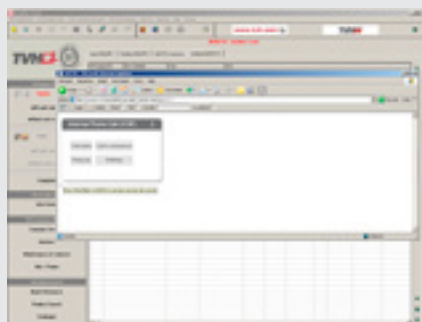
All our customers are important. TVH Quick Source is, therefore, available for free.

EXPECTATION.19

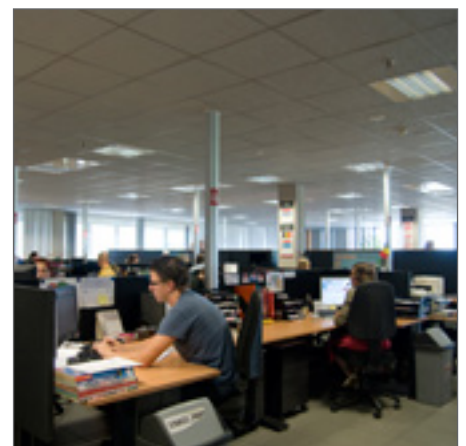
***By means of
TVH Quick Source,
customers can call
TVH for free.***

Via the telephone module, customers can call their contact person at the Sales Department or at E-commerce for free by means of a 'click of the mouse' saving both time and money.

EXPECTATION.20



VOIP - Call TVH for free



.21 EXPECTATION

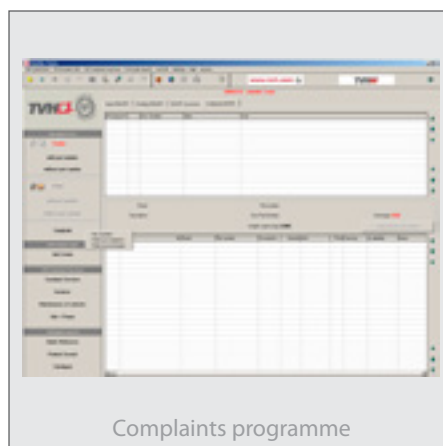
TVH Quick Source can be used to make price enquiries or place orders by means of TVH-references, original references or customer references. At any time, customers can verify the price and delivery time of the items and in case an item is out of stock, it is possible to demand an update of the different lead times. The system offers pictures and technical information for a wide variety of references. Customers can modify at any time during the input of the order, the characteristics of the part numbers they would like to order and therefore reduce the number of mistakes in orders. Also a follow up of the order status is possible and there is a link to request the tracking record. Moreover, direct communication is possible with the contact persons by means of options to modify the carrier, send cancellation requests, send questions regarding certain problems etc.

TVH Quick Source allows you to easily follow up your order processing and to trace your orders via the courier's site in real time.

.22 EXPECTATION

TVH Quick Source, version 5.3 also contains an extensive complaints module offering the customer the possibility to file at any time complaints and returns requests, and pass them on to the sales department. Complaints can therefore easily be processed by the contact persons and passed on to the technical department much quicker. Moreover, via the ComplaintsTrack module, customers can follow up complaints easily and have a limited control over the processing of complaints.

Via TVH Quick Source you can quickly input and follow up your complaints and returns on-line.





***Via TVH Quick Source
you can visualize and
print your invoices and
credits on-line at any
given time.***

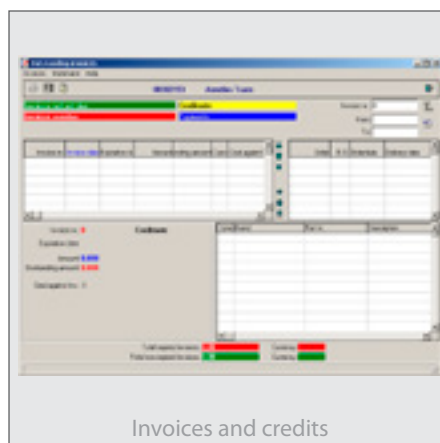
TVH Quick Source is also a document database, containing invoices, offers, order confirmations and shipment confirmations in pdf-format. Regular returns notes, returns notes for the surcharge part and credit notes have been integrated in the complaints module and can be printed. This allows the customers to anticipate and pass on valuable information to their end customers.

EXPECTATION.23

***All our product
catalogues can be
consulted free of
charge at any time
by means of TVH
Quick Source.***

To keep our customers up-to-date about our products, all of our product catalogues have been integrated in the programme. TVH Quick Source also contains a wide range of product catalogues (e.g. tyres, ignition switches, starters, seats and belts etc) which can be consulted free of charge. This allows us to offer the customer as much information as possible in an easy way. Customers do no longer need a paper version and have access to the most recent information about our product range.

EXPECTATION.24



Invoices and credits



.25 EXPECTATION

Two search modules are available in TVH Quick Source to enable the customer to identify spare parts himself for an extensive range of lift truck makes, saving both time and money. Parts can be identified on the basis of the truck details (Quick Reference) or the parts specifications / technical information (Product Search).

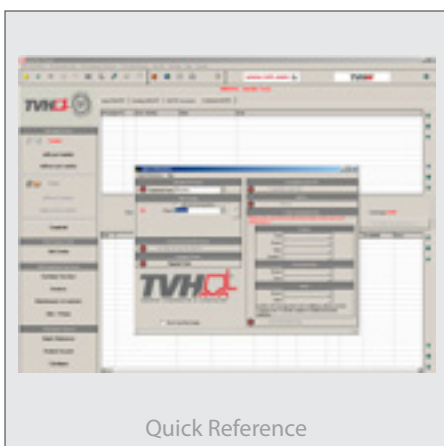
TVH Quick Source offers you the possibility of free and quick identification of spare parts by means of the Quick Reference module and Product Search.

.26 EXPECTATION

Customers can also benefit from a new service to print their own picking labels with their logo via TVH Quick Source.

The e-commerce helpdesk offers free support in case of questions and/or problems related to the TVH e-commerce tool and can be contacted at the following number +32 56 43 48 66.

By means of TVH Quick Source you can print your own part labels.



Quick Reference





4. COMMUNICATION

Since TVH - Group Thermote & Vanhalst is a company with international dimensions, a good communication with our customers is of paramount importance to us.

4.1. Office hours

Your internal sales advisor is always at your service during the office hours. Should your fixed contact person be absent, a backup is always available.

Offering valuable and accurate sales assistance requires well-defined office hours. We clearly communicate our office hours to our customers, bearing in mind the time differences, so that the customers know when to contact TVH. Therefore, we guarantee our customers that there's always a contact person present during office hours. If for some reason, we are unable to provide sales assistance to the customers we clearly communicate this information in advance.

Our customers are always TVH's no. 1 priority. To enable our customers to continue their business all year round we offer sales assistance with a minimum staff during Belgian Public Holidays.

Customers are allocated to one specific sales person to enhance the relationship with the customer, the knowledge and the confidence. There's a backup available should, for any reason, the fixed contact person not be available.





4.2. Documents

Two of the main goals of TVH are keeping the customers informed and make the internal processes as clear as possible. In practice, TVH abides by this rule by providing the customers both automatically and electronically, with a wide range of documents in as many as 19 different languages.

- The order confirmation assures the customer that the order placed was registered and validated.
- The transport confirmation indicates that the order placed is ready for transportation and will be sent.
- The shipment overview contains a list of all the shipments of one specific day.
- The back order report was created to inform the customers of the part numbers that remain pending, while the complaints overview serves to list all the statuses of the returns notes made for a particular customer.
- Our Accounts department sends a statement with the outstanding invoices and invoices to the customers.

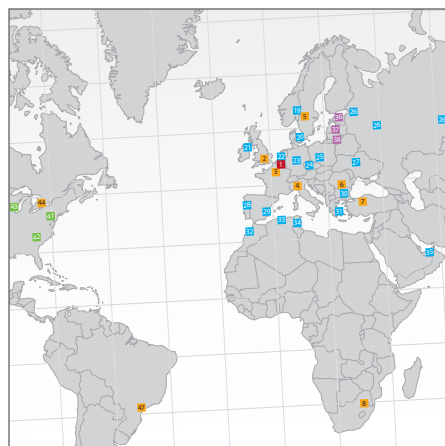
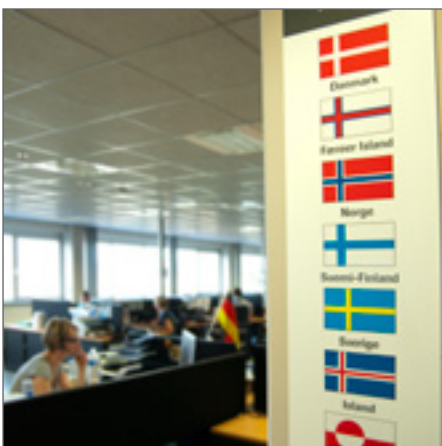
We can automatically and electronically provide you with any document regarding your order in 19 languages.

4.3. Languages

TVH has employed sales personnel, both Dutch and native speakers, with an excellent knowledge of languages. This allows TVH to offer the customers sales assistance in 31 languages and to overcome possible language barriers.

This asset has enabled TVH to increase the level of comprehension between the customers and the company and therefore, to reduce possible errors to a strict minimum. Moreover, customers are eager to mention specific problems and increasingly give suggestions that allow TVH to improve the customer service or make remarks.

We offer you sales assistance in 31 spoken languages.





4.4. Transport fare

The flat-rate transport cost is immediately consultable so that you always know your transport cost in advance.

For countries to which the system of "fixed transport fares" applies, the transport fare can be consulted in advance (at offer or order level), allowing the customer to pass the cost correctly on to the end customer.

30



ATTACHMENTS

TEST EQUIPMENT

5. TEST EQUIPMENT IN TVH

TVH - Group Thermote & Vanhalst has invested in a wide range of test devices by means of which we can pass stringent quality controls on various spare parts. The tests are designed in such a manner that a realistic work situation is generated during the tests. Please find below an overview of our in-house test equipment.

A. Test bench for hydraulic cylinders

This test bank, which has been developed internally, allows us to check all types of hydraulic cylinders for internal and external leakage as well as pressure. The tests can be performed statically and dynamically. By means of hydraulic oil pressure, we can continuously move the piston rod from a compressed position to a fully extended position.

At maximum pressure, we test the mechanical power and density for instance, of the main seals. At low pressure, which implies a low oil flow, the piston rod moves very slowly.

By measuring the pressure build-up before the piston rod starts moving, we can identify the static friction. The lower the friction is, the longer the seals will last. Switching to testing via the PLC-controls has made the testing process much simpler.

It also allows us to simulate a work situation which will give us sufficient info so as to provide the customer with a perfect and high-quality spare part. The tests are performed with filtered hydraulic oil at operating temperature. From every test, a report is drawn up which reflects the course of the pressure in the cylinder in function of time or movement of the piston rod. The test bank consists of two independent hydraulic aggregates so as to guarantee in all circumstances sufficient test capacity.





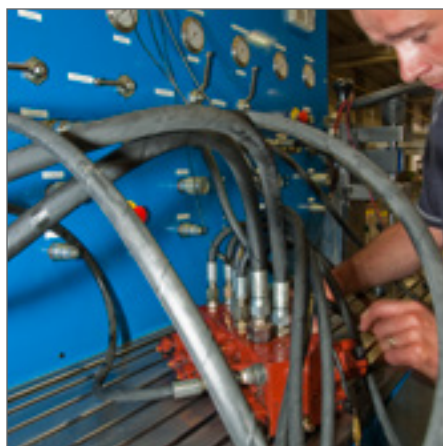
B. Test benches for hydraulic valves

Hydraulic valves are known to be valuable but also expensive parts of the hydraulic circuit because the working and safety of the machine depend on it. For these parts we have developed a test bank internally by means of which we can test almost every hydraulic valve in a way that is very close to the normal working situation. The test bank allows us to read at any time the operating pressure, contained pressure and possible internal leakage. After every test, a report is generated with the results and a copy of it is sent to the customers.

We can test the valves in two different ways:

- The valve block or orbitrol to be tested is coupled via the test bank to an adapted fork lift truck, which is also part of the test configuration. The valves on the fork lift truck are bridged to the valve subject to testing on the test bank. This way, all functions (lifting, inclining, etc) can be checked. By forcing the oil to the different users (lift cylinder, steering cylinder,...) all functions can be visualised on the test fork lift truck. The hydraulic components can thus be tested with or without pressure.
- The parts can also be tested with hydraulic nitrogen accumulators. This way, the accumulators create a counter pressure which, in fact, simulates pressure of the valve. Leakages, no matter how small they may be, will be revealed.

This test bank also combines a test device for orbitrols. Pump pressure, return and pressure can be registered and the check valves can be tested. Furthermore, the torque by means of which the steering wheel is operated, is measured as well. Light or heavy steering is granted a value. Nm and pulsations will be visible.





C. Flowmeter

This portable test device is used for measuring the hydraulic flow in the distribution valve. It can be used to measure the flow of the oil surge and it will reveal internal leakages and malfunctioning priority valves.

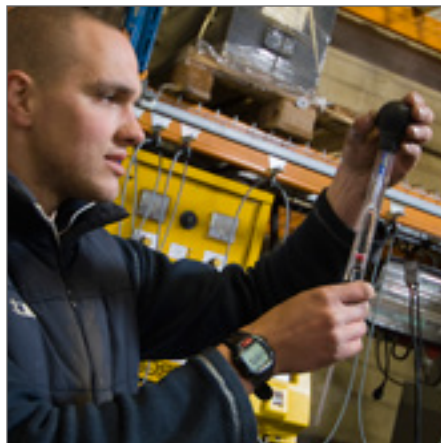
D. Test configuration for batteries and battery chargers

This test device can be used to measure cell pressure and capacity and to control the level of acid, the discharge course and the maximum pressure level of the batteries for both starter batteries and traction batteries. The results of the tests are shown in a graph. The curve inclination is an indication of battery sulfation.

To have a correct impression of the state of the charger, the following parameters need to be verified: the curve, how does the battery react, at what voltage does the charger stop charging and when does it resume charging.

This test configuration can also be combined with an electronic battery. A battery can be simulated in order to quickly determine for instance, the cut-in voltage and switch-off voltage. Faults can be simulated as well. If the customer files a complaint with respect to a charger, the cause is usually a failure in the battery.

A complete test report is available.





E. Tester for electric motors

Electric motors (12 to 80V, parallel or series) are always checked in an idle and dynamic state. The following parameters are always being scrutinised: power consumption, voltage drop and the general functioning of the motor. Sudden heating, vibrations or excessive power consumption give a good impression of the general condition of the motor. This test always precedes the test with the surge tester.

F. Surge tester

The surge tester allows us to test electric motors (both DC and AC motors) in a static way. The resistance of windings and connections is measured and compared mutually so as to check whether the electric balance is maintained.

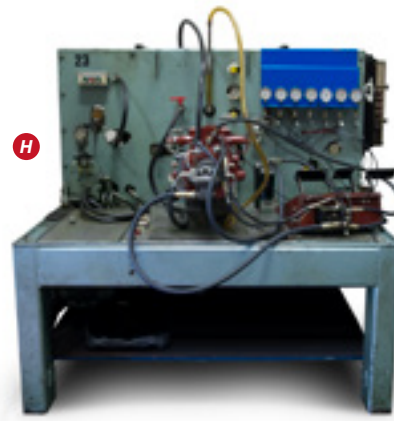
Short high-voltage peaks allow us to measure the insulation value between the conductors and enclosure as well as between the coats of varnish on the windings. Measurements can be stored electronically and be consulted in a later phase when a new repair or test is being carried out.

The surge tester allows us to store a different identity per motor, which implies that the device has an unseen number of applications and possibilities.

Thanks to this device we can, in case of repair of an electric motor, deliver with great certainty a decent and qualitative product to the customer.

The test results can be printed as well and be given to the customer.





G. Linde test truck for hydrostatic transmissions and orbitrols

To accurately test a hydrostatic transmission, it needs to be tested in a working situation as real as possible. Therefore, TVH has converted a Linde 351 into a test machine.

Every hydrostatic transmission from the Linde brand is fitted into the test truck and adjusted by our experienced mechanics before it leaves the workplace. The following functions are being checked: driving, braking, accelerating, balance between left and right wheel, standing still.

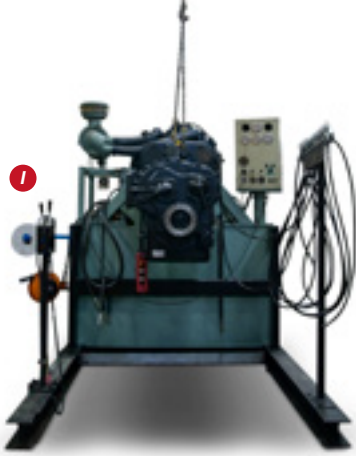
Also orbitrols can be quickly verified via the test trucks.

Every repair is assigned a code by means of which TVH can guarantee the customer a high quality product.

H. Test bench for hydrostatic axial plunger pumps

This test bank enables us to measure the flows, internal pressures and system pressure present in this type of axial plunger pumps and to register possible pressure losses.





I. Test bench for major automatic transmissions

On this test bank, an industrial automatic transmission is coupled to a V8 diesel engine and tested. Operating pressure, torque converter pressure, pump pressure and gear change pressure are shown at the same time.

During gear change, the pressure build-up or the pressure drop can easily be visualised.

The transmission will not be delivered in case of a major speed reduction or in case a certain pressure is not achieved.

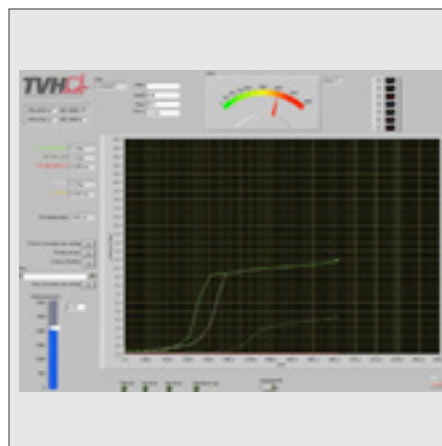
Should there be a difference in the functioning of the transmission after being fitted into the machine, the cause can be determined by means of simple pressure measuring at specific measuring points. In this case, our experienced mechanics are ready to help the customer out and to identify the problem.

J. Test bench for smaller automatic transmissions

On this test bank, an industrial automatic transmission is coupled to a hydraulic unit and the electronics needed in order to adjust continuously the rotational frequency and the gear.

The old regular pressure gauges were replaced by sensitive speed, pressure and temperature sensors so that now, the test can easily be carried out via a couple of clicks of the mouse. The tests are always carried out with both cold and warm oil.

Test reports are available and stored in our system. They can be sent to the customer.



K

K. Test bench for starters

TVH has invested in the development of a professional starter test bank, since it is very difficult to keep track of the specifications of the different starter producers (e.g. not every producer equals 1 Kw to 1000 Watt).

This test bank is developed in such way that different types of starters can easily be tested for longer and shorter time intervals.

Whilst testing, the following is simultaneously verified:

- voltage of the starter
- power absorbed by relay and motor
- outgoing speed of the pinion
- torque on the axe of the flywheel

The computer is a useful tool to analyse the information and to calculate the following:

- absorbed power
- lost power
- maximum torque in function of speed
- maximum current in function of pressure

These data are gathered in a test report (graph).

L

L. Test bench for reducers

Suitable for load testing both reducers that are driven horizontally and vertically. This unique machine allows us to thoroughly test the functioning of the gear boxes that provide the mechanical transmission between the electric motor and the wheels in electric lift trucks.

We test under load to simulate the actual situation in the machine in this way. Before testing, our engineers recondition the reducers completely. This way we maintain a guaranteed quality level.





Program: Fe-Ag
Operating: Fe-Ag (Aluminum)
gemiddelde (mV)

TVH Nr: schakel 4
Boven: 1.0037
Mist: 1.0037
Syndicat

Elementen concentratie

	C	Si	Mn	P	S	Cr	Mo	Ni
%	%	%	%	%	%	%	%	%
0.152	0.279	0.82	0.012	0.014	0.037	0.017	<0.000	
	Al	Co	Cu	Nb	Ti	V	W	Pb
%	%	%	%	%	%	%	%	%
0.004	<0.000	0.010	<0.000	<0.000	0.005	<0.000	<0.000	
	Ba	Mg	Au	Zr	Bi	Ce	Ca	B
%	%	%	%	%	%	%	%	%
0.000	0.000	0.017	0.000	0.000	0.000	0.000	0.000	0.001
	Zn	La	Fe					
%	%	%	%					
0.001	0.001	99.8						

Example of a test report of the spectrometer

The reducers are completely disassembled before reconditioning. We clean all parts thoroughly and sandblast the housings. We also replace all bearings, gaskets and any damaged gears standard. The assembly and adjustment are performed in the approved manner and by means of precision instruments.

M. Spectrometer

A spectrometer is an optical instrument which is used for analysing the composition of metals.

The instrument measures as follows:

- First, a spark curve creates a tiny molten pool at the surface of the part to be checked.
- A certain light beam from a specific area of the electromagnetic spectrum is reflected in this pool.
- In a following phase, the reflection is being analysed digitally as every metal type will show different values.

There's a coming and going of goods that arrive at TVH every day, which suggests that the spectrometer is used here on a daily basis. If the test results show that a certain spare part lacks the correct metal type, the part will be rejected.

If required, we are willing to deliver a test report in which the following elements are highlighted:

- C (carbonium)
- Cr (chromium)
- Mo (Molybdenium)
- Fe (Iron)



5	6	7	8	9	10	11	12	13
V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga
23	24	25	26	27	28	29	30	31
50.94	52.00	54.94	55.85	58.93	58.69	63.55	65.38	69.72
Vanadium	Chromium	Manganese	Iron	Cobalt	Nickel	Copper	Zinc	Gallium
Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In
41	42	43	44	45	46	47	48	49
92.91	95.94	98.91	101.07	101.07	106.42	107.87	112.41	114.82
Niobium	Molybdenum	Technetium	Ruthenium	Rhodium	Palladium	Silver	Cadmium	Indium
Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl
73	74	75	76	77	78	79	80	81
180.95	183.85	186.21	190.2	192.22	195.08	196.97	200.59	204.38
Tantalum	Tungsten	Rhenium	Osmium	Iridium	Platinum	Gold	Mercury	Thallium
Db	Sg	Bh	Hs	Mt				
105	106	107	108	109	110	111	112	113
(262)	(263)	(264)	(265)	(266)	(267)	(268)	(269)	(270)
Dubnium	Seaborgium	Bohrium	Hassium	Mitlergium				
Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy
58	59	60	61	62	63	64	65	66
140.12	140.91	144.24	(145)	150.36	151.97	157.25	158.93	162.50
Cerium	Praseodymium	Neodymium	Promethium	Samarium	Europium	Gadolinium	Terbium	Dysprosium
Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf
90	91	92	93	94	95	96	97	98
232.04	231.04	238.03	(237)	(244)	(243)	(247)	(247)	(251)
Thorium	Protactinium	Uranium	Neptunium	Plutonium	Americium	Curium	Berkelium	Californium



N. Hardness tester – scleroscope

Previous to the hardness test the type of steel is determined. The unit for 'hardness of steel' we use at TVH is Rockwell C. Regular steel (construction material) measures hardness 0 HRC, while for instance, the inner ring of a ball bearing is 60 HRC.

The test consists in dropping a diamond tipped hammer vertically from a fixed height onto the surface of the part under test with a predetermined pressure. If the material is soft, indentation will be about 0,3 mm while in a harder part it will only amount to 0,1 mm. The depth of the indentation is then converted to HRC value.

O. Tester for springs/gas springs

Two springs with different measurements can have different pressures, which implies that they have a different spring rate. To determine the spring rate, it is important to identify the force at pressure in function of the movement.

This test device creates a uniform velocity on the spring while below the spring a strain gauge measures the reaction force. The PC will convert the results pressure-distance in a graph and reveal the spring rate, either in single or different cycles.

This tester can be used for both springs and gas springs.





P. 3D measurement

3D test bank

This test device can be used to measure spare parts in a 3 dimensional way with an accuracy of 5 micron (0,000005 m). Measuring takes place in a conditioned room at the correct temperature to avoid expansion of the measured object.

This test instrument not only serves for measuring distances and circumferences, but also to perform geometry, check pitch circles etc and to verify whether imaginary axes are parallel.

3D measuring arm

The 3D measuring arm is similar to the test bank, however, it has the advantage of being mobile. Via a balanced arm all sides of the part can easily be measured, even the places that are difficult to reach. The measuring point gives at any time the xyz coordinates of its location. Wheelhubs, brake drums, flywheels have tolerances of 0,1 mm so measurements have to be very precise.

Q. Test bank for injection pumps

Injection pumps are being reconditioned and tested via the newest test methods.



R. Electronics

Our electronic department is one of the fastest growing departments of TVH and has over 35 qualified electronic engineers to give you support and to repair all your cards and controllers. Our repair programme is growing day by day and we keep on searching for qualified people to expand our programme and give our customers the service they deserve. By allowing our electronic engineers to specialise in 1 or 2 specific brands, we can offer experienced brand-specialists who deliver quality work.

Our R&D team is there to support our electronic engineers. They make schematics (reverse engineering) of printed circuit boards (pcb's) and develop all required test facilities and software to test our parts.

All controllers/pcb's carry a "tested" or "new part" label with a unique W-number. With this number we can see where and when we bought the part and to whom we sold it. By looking up the W-nr on our exchange cards, we can find out what was repaired before on the card (history of the card).

Some facts & figures :

- We repair more than 10000 cards a year.
- All controllers are thoroughly load tested.
- We give a 6 months warranty on all new, repaired and service exchange parts.
- You can send in your own card/controller for repair if TVH has no Service Exchange part available.
- We are also repairing:
 - Joysticks / displays / accelerators
 - HF chargers
 - Electronic parts for aerial lifts





Functional test

This tester was fully developed in-house. It contains sufficient data acquisition cards to check the functionality of all parts we are currently repairing. The functional tester includes multiple analog and digital I/O and supports various communication interfaces (CAN, RS232, RS485, IS9141-2, current loop,...). After a visual inspection and when the repair of a pcb/controller/joystick/display is finished, a functional test will be done. For the repair of displays/joysticks/pcb's, a functional test is sufficient. Controllers are always put through a second test, which will be a load test.

The functional tester gives us the possibility to:

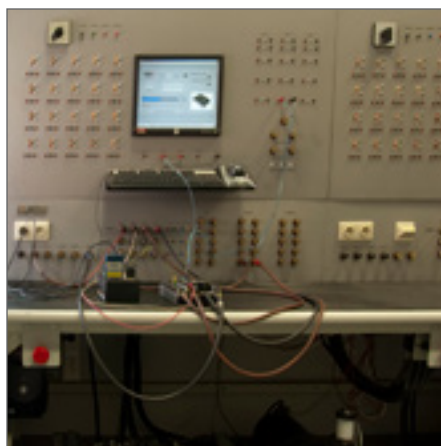
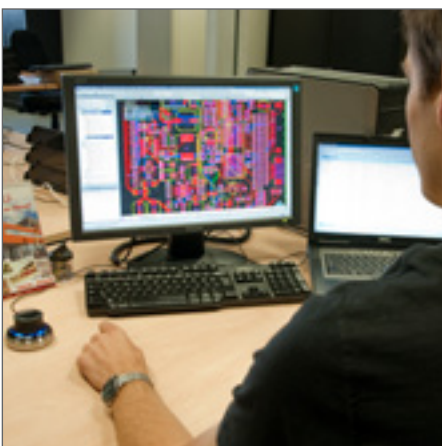
- upload / download software
- change settings of the controller
- do a manual test / full automatic test
- do loop tests / stress tests
- print a report

Load test

Next to the functional test, we have 2 different ways of load testing our controllers. For some of our popular controllers we have an automated tester (ATE), for the other controls we have 22 power testbenches with motor available. By testing a controller on its maximum power, we are able to detect "hard to find" problems. Every controller that is repaired by TVH is fully load-tested!

Power test benches

All 22 test benches are equipped with a motor and a footbrake. The technician will test all functionality and load the controller as long as is described in the specifications of the controller. At the same time the temperature of the controller is monitored. Some of the testbenches have a computer with interface cards, hall sensors to verify the current, CAN-cards to communicate with the controller,...





Automated load tester

This tester contains the same interface cards as we use for our functional tester. So we have enough I/O to test the Device Under Test (DUT). Our software makes it possible to choose between a fully automatic test or a manual test. When choosing for a fully automatic test the ATE will test the DUT at his maximum ratings for a predetermined time. We use real DC or AC motors to achieve realistic test conditions. Braking of the motor is done by a 3 phase motor which will regenerate the energy back into the mains. When the test is finished, a report will be printed. This report is connected to the unique W-number that is generated by the system. The W-number will be printed on a "tested label" and be put on the tested part.

Charger tester

This charger tester gives us the ability to load test all types of chargers up to 100Amp – 228Volt (including High Frequency chargers). By means of a "virtual battery" we can program the current and the voltage we want to test our charger on. With a potentiometer we are able to change the voltage of the "virtual battery" and walk through all charging phases in a short period of time. The computer gives us the possibility to draw a graph of the charging curve. With this tester we can test all chargers in minutes instead of hours when testing with a real battery.

Measuring equipment

Because we want to supply our customer a quality product, we have invested a lot of money in top-quality testing and measuring devices and software.

S. Extra

TVH closely cooperates with different renowned universities in order to make further analysis possible based on their knowledge, expertise and skills. The University of Ghent has already been contacted and involved in a project to research the amount of steel in forks.



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NOTES

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Quality Project

WITH THE QUALITY PROJECT TVH ENSURES
A CONSTANT CONTROL OVER THE QUALITY
OF THEIR PRODUCTS AND SERVICE. AT TVH
WE PUT EVERYTHING TO WORK TO MEET
OUR CUSTOMERS NEEDS IN EVERY WAY.
IF YOU HAVE A SUGGESTION ON HOW
WE CAN FURTHER IMPROVE QUALITY WE
WOULD BE GLAD TO HEAR IT FROM YOU.
KIND REGARDS - TVH QUALITY CONTROL TEAM