

Q-dummies Modification History

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1. Purpose

This memorandum is written to describe the configuration status of the Q-dummies with the eye on regulatory application of the dummies. The preparation of the document is requested by the GRSP Informal Group CRS testing in its meeting in Vienna on September 02, 2008,

2. Objective

This memorandum describes the final configuration of the Q-dummies that was frozen in spring 2004 and addresses all modifications applied to the Q-dummy family since then. The modification applied since the freeze of the products in 2004 are specified in terms of What, Why, When and Implications. This document is made to show, transparent for all parties, the consistency of the Q-dummies configuration and to support the confidence in the dummies as measurement tool in crash test tests procedures.

3. Summary

The modifications applied to the Q-dummy family, up to and inclusive the upgrade program in 2004 are performed as a part of the development phase in the EC projects CREST and CHILD. In 2004 a Q3-Upgrade kit was made available and 18 of the 23 Q3-dummies in the market were upgraded. From the other dummies in the Q-family only three Q6 are delivered to the market before 2004. All improvements were included in the Q6 design before it was delivered to the market, so the three Q6 dummies in the market in 2004 do not need to be updated. All dummies available in the market are in compliance with the frozen configuration, except the five (5) Q3 dummies that are no yet upgraded. A few modifications were implemented to the Q-dummies after 2004, to optimise or adjust the production quality and improve the dummy durability. These changes do not affect the dummy configuration with regards to form, fit and function and will not affect the impact test results obtained with the dummies. It is concluded that the dummy configuration is consistent and no changes that affects their output in impact tests are applied to the dummies since the freeze of the product in 2004.

4. Input, Method and Results

At first an overview of the Q-dummies delivery is given per dummy type describing when dummy sales started and in what configuration the dummies were delivered.

Secondly the upgrade program is described with a short overview of the upgrade kit content.

Thirdly the communication of Q dummy development partners to the market is summarised.

Finally an overview of the modifications applied to the dummies after the product freeze is provided. These changes are described in terms of What, Why, When and Implications.

4.1 Overview of dummy deliveries

The history of the dummy development goes back to 1996. In November 1996 the first Q3-dummy prototype was made available to be exposed to an extensive internal TNO evaluation program. After several developments steps the first production version of the Q3-dummy was delivered to the European CREST-project for external evaluation in November 1998. At that time the Q3-dummy was also made available for the market. In the years after that the other Q-family member Q6, Q1, Q1.5 and Q0 were developed and evaluated. The evaluation resulted in several improvements up to the configuration freeze in spring 2004. In Table 1 the numbers of Q-dummies delivered through the years are given. Below a brief description of development is given per Q dummy family member.

Table 1: Deliveries to the market of Q-dummies through the years

Dummy	Calendar year											Remark
	98	99	00	01	02	03	04	05	06	07	08	
Q0								1	...	...	...	Prototype 2003
Q1								1	...	...	...	Prototype 2000
Q1.5							1	...	...	...	...	Prototype 2002
Q3	6	4	4	5	2	2	1	...	...	...	...	Prototype 1996
Q6					2	1	0	...	...	...	...	Prototype 2000
Q3 upgrade kits							8	5	4	0	1	

Q0 dummy

The development of the Q0 dummy started in 2002 within the European CHILD-project. In September 2003 three dummies were available for evaluation outside FTSS and for accident reconstructions in the CHILD project. The evaluation inside FTSS and in the CHILD project did not result in changes to the dummy design. From 2005 on the dummy is delivered to the market.

Q1 dummy

The development of the Q1 dummy started quite early, in February 2000 the first prototype dummies were delivered to the European CREST-project. The evaluation of this dummy took place parallel to the evaluation of the Q3 and Q6 dummies. The changes to the design as a result of feedback from the CREST project were implemented in several improvement steps. The delivery of the Q1 dummy to the market started in 2005 after the freeze configuration. No upgrade program was required for this dummy because there were no dummies in the market before the configuration became final.

Q1.5 dummy

The development of the Q1.5 dummy was required to provide a representation of the high end occupant for testing of Group 0+ Child Restraint Systems. The dummy, an up-scaling of the Q1 dummy, became available in 2002. Two dummies were available through FTSS for loan. Lots of the lessons learned during the evaluation Q1, Q3 and Q6 were directly implemented in the Q1.5. The delivery of the Q1.5 dummy to the market started in 2004 after the freeze configuration. No upgrade program was required for this dummy because there were no dummies in the market before the configuration became final.

Q3 dummy

The development of this dummy started in 1996 and the first prototype was presented in November of that year on the Stapp-conference. After many design iterations the dummy

prototype was delivered to the CREST consortium for further evaluation in November 1998. From that moment on the dummy was also available to the market. Several test laboratories purchased the dummy to facilitate their participation in European CREST- and CHILD-projects and or to obtain experience with it in regulatory and consumer test procedures for child restrained systems. The feedback from the users as well as the evaluation results and experience gained in the CREST- and CHILD projects resulted in further dummy improvements with regards to Biofidelity, Repeatability and Reproducibility, Durability and Handling. In spring 2004 the configuration was frozen and upgrade kits were marketed to bring all dummies to the latest standard. Since spring 2004, 18 upgrade kits are delivered to the market whereas 23 dummies available in the market at that time. In the next paragraph more details on the upgrade kit implementation are given.

Q6 dummy

The development of the Q6 dummy started quite early, in February 2000 the first prototype dummies were delivered to the European CREST-project. The evaluation of this dummy took place parallel to the evaluation of the Q1 and Q3 dummies. The changes to the design as a result of feedback from the CREST project were implemented in several improvement steps. The delivery of the Q6 dummy to the market started in 2002 before the configuration freeze of the complete Q-family. However, the all significant changes were implemented in the Q6 design before the first delivery to the market. Therefore the Q 6 dummies do not need to be updated.

4.2 Upgrade program content

The upgrade program to bring all dummies available in the market to the final standard was defined in spring 2004. As described above only the Q3 dummy that was widely available in the market needed to be upgraded. The bill of material for the upgrade kit as well as the main characteristics of the consisting parts is listed below:

Q3 UPGRADE bill of material with their main part characteristics

Q3 UPGRADE KIT to be applied to 020-0000 to get 020-0001

(Screws are omitted in this overview)

- **Head Frontal Assembly**
Part number: 020-1020
 - *New skin material*
 - *Higher mass*
 - *Revised interface with neck*
 - *Four holes in the top to make the neck interface bolts better accessible*
- **Rear Skull Cap Assembly**
Part number: 020 -1020
 - *New skin material*
- **Head Accelerometer Mounting Bracket Assembly**
Part number: 020-1013
 - *Suitable for application of linear accelerometers*
(Optional: Bracket allowing angular rate sensors application)
- **Neck Assembly, Tested and Certified w/Neck Cable Assembly**
Part number: 020-2100
 - *Atlas and OC joint deleted*
 - *Neck rubber segmented in three parts by two aluminium disks*
 - *Fibre cord neck cable*
 - *Lower mass*
- **Neck Torso Interface Plate**
Part number: 020-2015
 - *Interface adapted to the new neck*

- **Clavicle Q3, modified**
Part number: 020-3201
 - *To suite with new shoulder-spine interface parts*
- **Rubber Shoulder Spine Interface RH and LH**
Part numbers: 020-3310 and 020-3320
 - *Rubber shoulder to spine interface part*
 - *Higher mass*
- **Thoracic Spine (Spring Pot)**
Part number: 020-4006 (for string potentiometer)
(Optional Q3UPGRADE-2: Thoracic spine for IR-TRACC application - Part number 020-4401)
 - *Lower mass*
- **Pelvis Flesh, Moulded**
Part number: 020-7010
 - *Changed skin material*
- **Optional Q3-UPGRADE-2: IR-TRACC provisions kit**
Part numbers: 020-4402, -4403, -4404, -4405, -4406, -4407 and -4411
(together with the dedicated thoracic spine 020-4401)
 - *Accurate measurement under high velocity loading conditions*

Note: All Q6 dummies are equipped with an IR-TRACC and all Q1 and Q1.5 dummies are equipped with a string potentiometer chest deflection measurement device. The later two dummies have not enough space to accommodate the IR-TRACC hardware)

Note: Because during the development dummies were updated step by step in the CREST and CHILD-project there may be parts in the market that have not all the mentioned features and characteristics. If deviations are found and doubts on the configuration arise, a careful inspection of the dummy configuration and contact with the dummy supplier is recommended. The part serial number can be used to trace back the modification status.

At the time that the upgrade kits became available there were a total number of 23 Q3 dummies delivered to the market. Some of these dummies were updated step by step in the development process, while the majority still had the old configuration. In total 18 UPGRADE KIT's are delivered: Eight (8) Q3 UPGRADE kits for chest deflection string potentiometer and ten (10) Q3 UPGRADE-2 kits for chest deflection IR-TRACC application. Additionally two (2) thoracic spines for IR-TRACC and sets of corresponding IR-TRACC hardware are delivered. All 18 upgrade kits can be related to known dummies.

It can be concluded that:

- Five (5) dummies available in the market have not been upgraded with an upgrade kit. These dummy are all at users in Japan.
- At least eleven (11) Q3 dummies are still equipped with the string potentiometer hardware. (The 5 not upgraded dummies and the 6 dummies that are upgrade kit for the potentiometer version).

Recommendation:

To eliminate strange and non repeatable chest deflection results that can occur with the string potentiometer configuration, it is recommended to apply the IR-TRACC configuration in all Q3 dummies.

4.3 Communication to the market

Occasions of communication

Since January 2004 the configuration freeze as well as the content of the upgrade kits is communicated to the market at several events. The following list provides a summary of those events:

2004:

- Quotations of Q3-UPGRADE KIT (String potentiometer version) send to all Q3 dummy users. The quotations were accompanied with an explanation of the reason of the changes. (April)
- Technical Sheet Q-dummies used in the FTSS booth on exhibitions. (October)
- FTSS NewsLine article on Q dummies and the update program. (November)
- W. Onvlee and M. Carlson (both FTSS), “Development and Validation of Updated Q-dummy Family”, International Conference Protection of Children in Cars, Munich 2004. (December)

2005:

- Quotations of Q3-UPGRADE-2 KIT (IR-TRACC version) send to Q3 dummy users on request. The quotations were accompanied with an explanation of the reason of the changes. (April)
- FTSS NewsLine advertisement of the Q-family. (April)
- K.de Jager (TNO), Assessing new Child Dummies and Criteria for Child Occupant Protection in Frontal Impact, Presented on behalf of EEVC WG12 and 18, Paper number 05-0157, ESV 2005. (June)
- K. de Jager and M. Bosch (both TNO), “Progress on Child Dummy Development”, International Conference Protection of Children in Cars, Munich 2005. (December)

2006:

- C.D. Waagmeester (FTSS), “Q-dummy Updates”, CHILD-project dissemination workshop held in Berlin. This workshop was attended by several representatives from regulators and dummy user. (May)
- Q-dummies seminar held in Heidelberg. For this seminar all Q-dummy users were invited. The seminar was attended by dummy technicians. (June)
- Technical Sheet Q-dummies used in the FTSS booth on exhibitions updated. (October)
- Françoise Brun-Cassan, CHILD presentation in TRA-conference in Sweden.
- CHILD/APSN workshop during the International Conference Protection of Children in Cars, Munich 2006. Kate de Jager presented Q-dummies research progress and results. (December)

2007:

- Updated manuals for Q1 and Q1.5 (January),
- Updated manuals for Q3 and Q6 (July)
(Manuals available through download from internet: <https://select.ftss.com>.)

2008:

- Submission by EEVC Steering committee of the EEVC WG12 and 18 report “Q-dummies Report – Advanced Child Dummies and Injury Criteria for Frontal Impact” EEVC document number: 514, April 2008.

General:

- During SAE shows and other exhibitions the Q-dummies are showed in the FTSS booth and information is given through personal contacts and the Technical Sheet Q-dummies.

Dummy Manual Updates

To line up the content of the dummy documentation with their final configuration the dummy manuals were updated. The new manuals are submitted in January 2007 (Q1 and Q1.5) and July 2007 (Q3 and Q6). In these manuals a detailed breakdown of the dummy is given in pictures and tables. The pictures indicate the part numbers and the tables give per body part

for all the consisting parts the part numbers, parts name and quantity. An example of the information given in the manuals is given in Figure 1. The most up to date version of the manuals can be down loaded from internet through: <https://select.ftss.com>.

Round about the time that the Q3Upgrade kits were introduced the part numbering system of the dummies was directly coupled to the drawing where as previously a letter code system was used. This system change can make it difficult to compare the part identification on the Q3 dummy hardware with the part numbers in the Q3 dummy manual. When these problems arise in the process of checking the Q3 dummy configuration it is recommended to make contact with the dummy manufacturer.

Note: The manual of Q0 is still in its draft form. The main open item for this dummy is the establishment of a proper neck certification procedure. A special head form is currently under development. With this head form a proper test procedure will be developed.

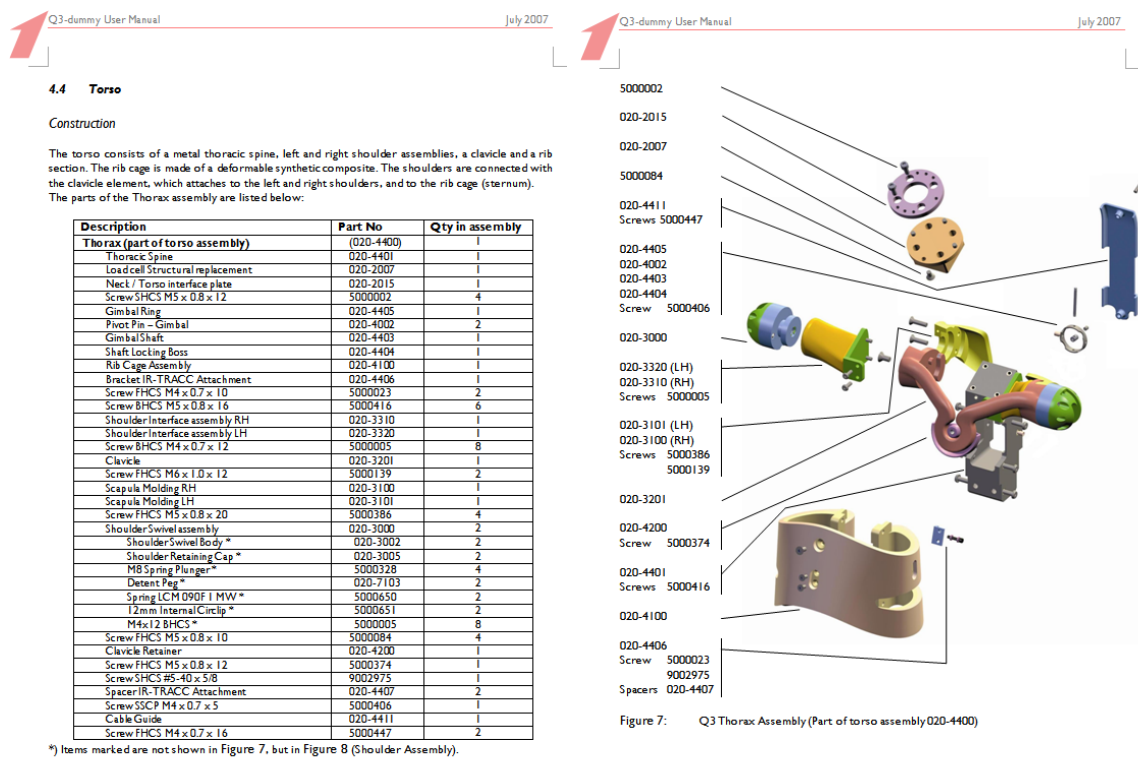


Figure 1: Example of the configuration information given in the Q dummy manuals (Q3 dummy manual pages 19 and 20)

4.4 Modifications to the dummies since spring 2004

Since 2004 some product improvements are implemented to overcome manufacturing problems, to address user feedback and to solve customer complaints. In this paragraph these changes applied to the dummies are described. The modification are described in terms of What, Why, When and Implications. In general it can be stated with regards to implication that consistent dummy certification test results safeguard the consistent performance of the dummy.

4.4.1 Neck durability improvements (Q1, Q1.5 and Q3)

Part name : Q3 Neck Assembly Tested and Certified

Part number : 020-2100 used on Q1, Q1.5 and Q3

What : Tighter requirements corridor set for neck rubber material formulation with anti-ozonate doping. New material vendor found that can guarantee consistent material formulation within the tighter requirements corridor to ensure material toughness at high stress levels.
Moulding shape slightly modified: increased corner radii to mitigate stress concentration in the rubber segments

Why : Relative new necks showed small surface cracks in the rubber and some users reported neck failures. The sudden change of neck strength was investigated and could be contributed variation in the rubber compound formulation and the omission of anti-ozonate doping. The first vendor was not able to control his process consistently between the required boundaries. Another vendor was selected to overcome the problem

When : Problem arose in June 2006 and was solved in November 2006.
Customers that suffered from this issue got replacement parts free of charge.

Implications : No affect on bending performance characteristic as is proven by compliance with the biofidelity corridor as well as the certification requirements. Old parts that does not show the surface cracks and pass the certification tests can be used as they are.

4.4.2 Rib cage durability (Q3 only)

Part name : Rib Cage Assembly

Part number : 020-4100 (applicable for Q3 only)

What : Upstanding flange at clavicle mount location has got a radius cut out at mid sagittal plane. (Only for Q3, other dummy do not have this upstanding flange)

Why : Customers suffered early crack initiation. High stresses in the top of the flange due to bending promote fatigue crack initiation.

When : May 2007
Parts identification controlled by serial number

Implications : The modification of the flange has no affect on the overall stiffness of the ribcage section at the mid sagittal plane. Improved fatigue life for frontal impacts by reduction of stress concentration. No affect on the impact performance of the rib cage as is proven by compliance with the certification requirements. Old parts that comply with their certification requirements can be used as they are.

4.4.3 Glossier finish of moulded parts

Part name : Moulded parts

Part number : (several)

What : Previously the surface finish of the moulded parts was satin. This may change to a glossier finish.

Why : The production of the Q-dummies is shifted from the United Kingdom to America. The moulding process is harmonised with the process applied for the production of parts for other dummies like Hybrid III and ES-2.

When : The shift of production was finished in 01 November 2007
Parts identification controlled by serial number

Implications : This visible change to the appearance of dummies, do not have any implication for the performance of the dummies. Old parts that comply with their certification requirements can be used as they are.

4.4.4 Lower arm strength (Q3 only)

Part name : Q3 Lower Arm Assembly

Part number : 020-9302 (left) and 020-9402 (right)

What : Stainless steel reinforcement was moulded into the bone at the elbow end

Why : Q6 arm failed in 2004 in a frontal test: When the shoulder bend forward arms can twist and load the lower arm in upper arm clevis. Q6 was reinforced in 2004 and Q3 was reinforced later as proactive measure to try to avoid this failure.

When : October 2005.
Parts identification controlled by serial number

Implications : None: Lower arm mass still within specification. Old parts can be used as they are.

5. Discussion

The Q dummy family that up to now consists of the Q0, Q1, Q1.5, Q3 and Q6 is developed between 1998 and 2004. The final configuration of the Q-dummies is frozen in 2004 at that time there were 23 Q3 and three Q6 delivered to the market. The Q6 dummy design embodied all improvements right from the first delivery to the market. The Q3 dummies, however needed an update to be brought to the final configuration. With the marketing of the Q3 UPGRADE kits for the string potentiometer version and the Q3-UPGRADE-2 kits for the IR-TRACC version the users updated the configuration of 18 Q3 dummies. The possible version variations that currently exist in the market are:

- 18 Q3 dummy upgrade kits are delivered all upgrade kits can be related to know dummies.
- Five (5) dummy are still in the old configuration. All these Q3 dummies are in Japan
- Six (6) Q3 dummies are still equipped with a string potentiometer to measure the chest deformation. In certain test condition the string potentiometer has proven to be inaccurate producing strange non-repeatable result. To prevent this it is recommended to use the IR-TRACC version.
- The Q-dummies that were used during the development phase were updated step by step following the improvements that were introduced. Some improvements that were judged not to be relevant for the dummy performance may not be implemented at customers. These kinds of improvements are mainly related to handling. An example of this is the holes in the top of the head that give easy access to the head-neck attachment bolts. The dummy heads without those holes have performance equivalent to those with the holes. Handling related changes to the Q-dummies that are not significant for their impact test performance are:
 - Four holes in the head to provide easy access to the head-neck bolts (2004)
 - Hip cups that allow friction setting (optional since 1999)
 - Wiring cover at the back of the thoracic spine is adapted and optimised several times.
 - Customized wiring system for on board data acquisition (optional)

6. Conclusions and Recommendations

Conclusion

It is concluded that the dummy configuration is consistent and no changes that affects their output in impact tests are applied to the dummies since the freeze of the product in 2004.

There are five (5) Q3-dummies in Japan that are not update with an upgrade kit, these dummies are still in the old configuration. An additional number of six (6) dummies in Europe are still equipped with the old string potentiometer to measure chest deflection.

Recommendations

With regards to Q3 dummies it is recommended to replace all chest deflection spring potentiometers with chest deflection IR-TRACC's to eliminate strange a non-repeatable chest deflection results.

In case of doubts on Q3-dummy parts available in test labs it is recommended to check their status. The Q3-dummy manual can be used as a guideline to perform this check. The manufacturer can help to translate old part numbers to the current ones that are used in the manual. The part serial numbers can be used to trace the modification status of the dummy parts in the manufacturer's production logs.