

CERTIFICATION PROCEDURE FOR HIII 5% FEMALE LOWER LEG AND FOOT

1. UPPER FOOT IMPACT TEST

- 1.1. The objective of this test is to measure the response of the Hybrid III 5% foot and ankle to well-defined, hard faced pendulum impacts.
- 1.2. The complete Hybrid III 5% lower leg assembly, left (.....-....) and right (.....-....), equipped with the foot and ankle assembly, left (880105-650) and right (880105-651), shall be used, including the knee assembly. The load cell simulator (78051-319 Rev A) shall be used to secure the knee assembly (78051-16 Rev B) to the test fixture.
- 1.2. Test procedure
 - 1.3.1. Each leg assembly shall be maintained (soaked) for four hours prior to the test at a temperature of $22\text{ °C} \pm 3\text{ °C}$ and a relative humidity of 40 ± 30 per cent. The soak period shall not include the time required to reach steady state conditions.
 - 1.3.2. Clean the impact surface of the skin and also the impactor face with isopropyl alcohol or equivalent prior to the test. Dust with talc.
 - 1.3.3. Align the impactor accelerometer with its sensitive axis parallel to the direction of impact at contact with the foot.
 - 1.3.4. Mount the leg assembly to the fixture shown in Figure 1. The test fixture shall be rigidly secured to prevent movement during impact. The centre line of the femur load cell simulator (78051-319) shall be vertical with a tolerance of $\pm 0.5^\circ$. Adjust the mount such that the line joining the knee clevis joint and the ankle attachment bolt is horizontal with a tolerance of $\pm 3^\circ$, with the heel resting on two sheets of a flat low friction (PTFE sheet) surface. Ensure that the tibia flesh is located fully towards the knee end of the tibia. Adjust the ankle such that the plane of the underside of the foot is vertical and perpendicular to the direction of impact with a tolerance of $\pm 3^\circ$ and such that the mid sagittal plane of the foot is aligned with the pendulum arm. Adjust the knee joint to $1.5 \pm 0.5\text{ g}$ range before each test. Adjust the ankle joint so that it is free and then tighten just sufficiently to keep the foot stable on the PTFE sheet.
 - 1.3.5. The rigid impactor comprises a horizontal cylinder diameter $50 \pm 2\text{ mm}$ and a pendulum support arm diameter $19 \pm 1\text{ mm}$ (Figure 4). The cylinder has a mass of $1.25 \pm 0.02\text{ kg}$ including instrumentation and any part of the support arm within the cylinder. The pendulum arm has a mass of $285 \pm 5\text{ g}$. The mass of any rotating part of the axle to which the support arm is attached should not be greater than 100 g . The length between the central horizontal axis of the impactor cylinder and the axis of rotation of the whole pendulum shall be $1,250 \pm 1\text{ mm}$. The impact cylinder is mounted with its longitudinal axis horizontal and perpendicular to the direction of impact. The pendulum shall impact the underside of the foot, at a distance of $185 \pm 2\text{ mm}$ (157 mm proposed) from the base of the heel resting on the rigid horizontal platform, so that the longitudinal centre line of the pendulum arm falls within 1° of a vertical line at impact. The impactor shall be guided to exclude significant lateral, vertical or rotational movement.
 - 1.3.6. Allow a period of at least 30 minutes between successive tests on the same leg.
 - 1.3.7. The data acquisition system, including transducers, shall conform to the specifications for CFC 600, as described in ISO 6487.

1.4. Performance specification

- 1.4.1. When each ball of the foot is impacted at **6.7 (\pm 0.1) TBD** m/s in accordance with paragraph 1.3., the maximum lower tibia bending momentum about the y-axis (M_y) shall be **120 \pm 25 Nm TBD**.

2. LOWER FOOT IMPACT TEST WITHOUT SHOE

- 2.1. The objective of this test is to measure the response of the Hybrid III 5% female foot skin and insert to well-defined, hard faced pendulum impacts.

- 2.2. The complete Hybrid III 5% female lower leg assembly, left (**.....-...**) and right (**.....-...**), equipped with the foot and ankle assembly, left (880105-650) and right (880105-651), shall be used, including the knee assembly. The load cell simulator (78051-319 Rev A) shall be used to secure the knee assembly (78051-16 Rev B) to the test fixture.

2.3. Test procedure

- 2.3.1. Each leg assembly shall be maintained (soaked) for four hours prior to the test at a temperature of 22 ± 3 °C and a relative humidity of 40 ± 30 per cent. The soak period shall not include the time required to reach steady state conditions.
- 2.3.2. Clean the impact surface of the skin and also the impactor face with isopropyl alcohol or equivalent prior to the test. Dust with talc. Check that there is no visible damage to the energy absorbing insert to the heel.
- 2.3.3. Align the impactor accelerometer with its sensitive axis parallel to the impactor longitudinal centre line.
- 2.3.4. Mount the leg assembly to the fixture shown in Figure 2. The test fixture shall be rigidly secured to prevent movement during impact. The centre line of the femur load cell simulator (78051-319) shall be vertical with a tolerance of $\pm 0.5^\circ$. Adjust the mount such that the line joining the knee clevis joint and the ankle attachment bolt is horizontal with a tolerance of $\pm 3^\circ$ with the heel resting on two sheets of a flat low friction (PTFE sheet) surface. Ensure that the tibia flesh is located fully towards the knee end of the tibia. Adjust the ankle such that the plane of the underside of the foot is vertical and perpendicular to the direction of the impact with a tolerance of $\pm 3^\circ$ and such that the mid sagittal plane of the foot is aligned with the pendulum arm. Adjust the knee joint to 1.5 ± 0.5 g range before each test. Adjust the ankle joint so that it is free and then tighten just sufficiently to keep the foot stable on the PTFE sheet.
- 2.3.5. The rigid impactor comprises a horizontal cylinder diameter 50 ± 2 mm and a pendulum support arm diameter 19 ± 1 mm (Figure 4). The cylinder has a mass of 1.25 ± 0.02 kg including instrumentation and any part of the support arm within the cylinder. The pendulum arm has a mass of 285 ± 5 g. The mass of any rotating part of the axle to which the support arm is attached should not be greater than 100 g. The length between the central horizontal axis of the impactor cylinder and the axis of rotation of the whole pendulum shall be 1.250 ± 1 mm. The impact cylinder is mounted with its longitudinal axis horizontal and perpendicular to the direction of impact. The pendulum shall impact the underside of the foot, at a distance of **62 ± 2 mm (52 mm proposed)** from the base of the heel resting on the rigid horizontal platform, so that the longitudinal centre line of the pendulum arm falls within 1° of a vertical line at impact. The impactor shall be guided to exclude significant lateral, vertical or rotational movement.
- 2.3.6. Allow a period of at least 30 minutes between successive tests on the same leg.

2.3.7. The data acquisition system, including transducers, shall conform to the specifications for CFC 600, as described in **ISO 6487**.

2.4. Performance specification

2.4.1. When each heel of the foot is impacted at 4.4 ± 0.1 m/s **TBD** in accordance with paragraph 2.3., the maximum impactor acceleration shall be 295 ± 50 g **TBD**.

3. LOWER FOOT IMPACT TEST (WITH SHOE)

3.1. The objective of this test is to control the response of the Shoe and Hybrid III 5% female heel flesh and ankle joint to well-defined hard faced pendulum impacts.

3.2. The complete Hybrid III lower leg assembly, left (.....-....) and right (.....-....), equipped with the foot and ankle assembly, left (880105-650) and right (880105-651), shall be used, including the knee assembly. The load cell simulator (78051-319 Rev A) shall be used to secure the knee assembly (78051-16 Rev B) to the test fixture. The foot shall be fitted with the shoe specified in Annex 5, paragraph 2.9.2.

3.3. Test procedure

3.3.1. Each leg assembly shall be maintained (soaked) for four hours prior to the test at a temperature of 22 ± 3 °C and a relative humidity of 40 ± 30 per cent. The soak period shall not include the time required to reach steady state conditions.

3.3.2. Clean the impact surface of the underside of the shoe with a clean cloth and the impactor face with isopropyl alcohol or equivalent prior to the test. Check that there is no visible damage to the energy absorbing insert to the heel.

3.3.3. Align the impactor accelerometer with its sensitive axis parallel to the impactor longitudinal centre line.

3.3.4. Mount the leg assembly to the fixture shown in Figure 3. The test fixture shall be rigidly secured to prevent movement during impact. The centre line of the femur load cell simulator (78051-319) shall be vertical with a tolerance of $\pm 0.5^\circ$. Adjust the mount such that the line joining the knee clevis joint and the ankle attachment bolt is horizontal with a tolerance of $\pm 3^\circ$, with the heel of the shoe resting on two sheets of a flat low friction (PTFE sheet) surface. Ensure that the tibia flesh is located fully towards the knee end of the tibia. Adjust the ankle such that a plane in contact with the heel and sole of the underside of the shoe is vertical and perpendicular to the direction of impact with a tolerance of $\pm 3^\circ$ and such that the mid sagittal plane of the foot, and shoe is aligned with the pendulum arm. Adjust the knee joint to 1.5 ± 0.5 g range before each test. Adjust the ankle joint so that it is free and then tighten just sufficiently to keep the foot stable on the PTFE sheet.

3.3.5. The rigid impactor comprises a horizontal cylinder diameter 50 ± 2 mm and a pendulum support arm diameter 19 ± 1 mm (Figure 4). The cylinder has a mass of 1.25 ± 0.02 kg including instrumentation and any part of the support arm within the cylinder. The pendulum arm has a mass of 285 ± 5 g. The mass of any rotating part of the axle to which the support arm is attached should not be greater than 100 g. The length between the central horizontal axis of the impactor cylinder and the axis of rotation of the whole pendulum shall be $1,250 \pm 1$ mm. The impact cylinder is mounted with its longitudinal axis horizontal and perpendicular to the direction of impact. The pendulum shall impact the heel of the shoe in a horizontal plane which is a distance of 62 ± 2 mm (**52 mm proposed**) above the base of the dummy heel when the shoe is resting on the rigid horizontal platform, so that the longitudinal centre line of the pendulum arm falls within one degree of a vertical line at impact. The impactor shall be guided to exclude significant lateral, vertical or rotational movement.

- 3.3.6. Allow a period of at least 30 minutes between successive tests on the same leg.
- 3.3.7. The data acquisition system, including transducers, shall conform to the specifications for CFC 600, as described in **ISO 6487**.
- 3.4. Performance specification
 - 3.4.1. When the heel of the shoe is impacted at **6.7 (\pm 0.1) TBD** m/s in accordance with paragraph 3.3., the maximum Tibia compressive force (F_z) shall be **3.3 \pm 0.5 kN TBD**.

Figure 1

Upper foot impact test

Test set-up specifications

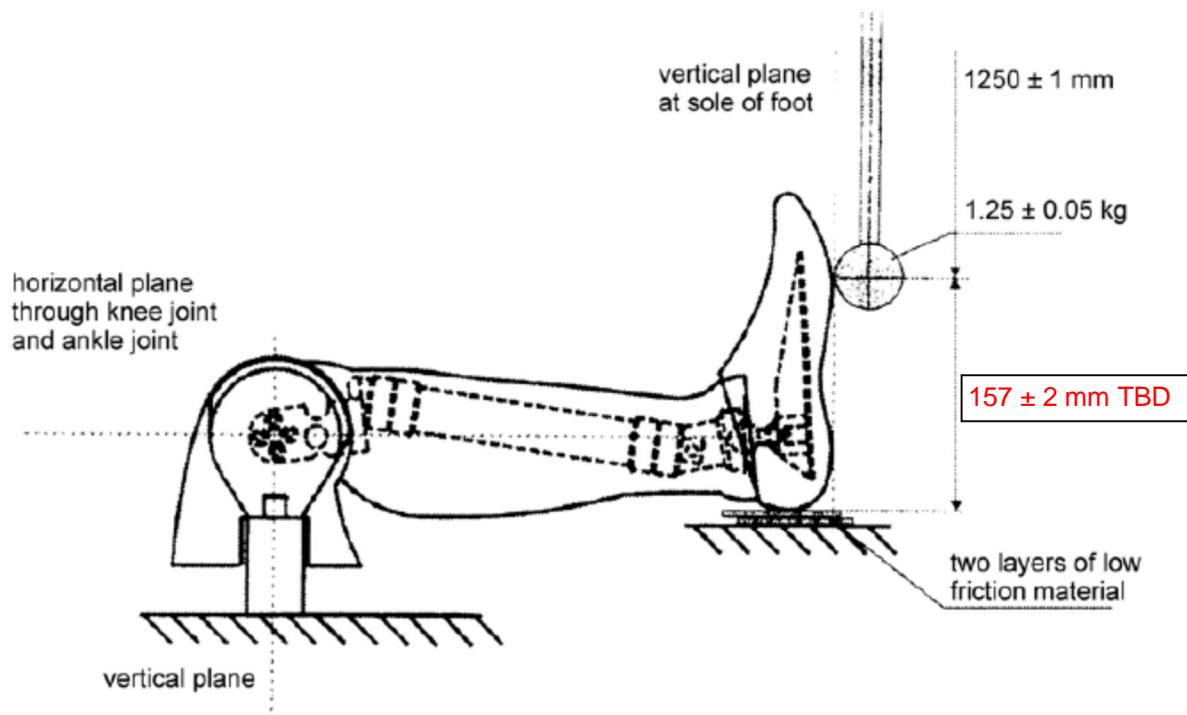


Figure 2

Lower foot impact test (without shoe)

Test set-up specifications

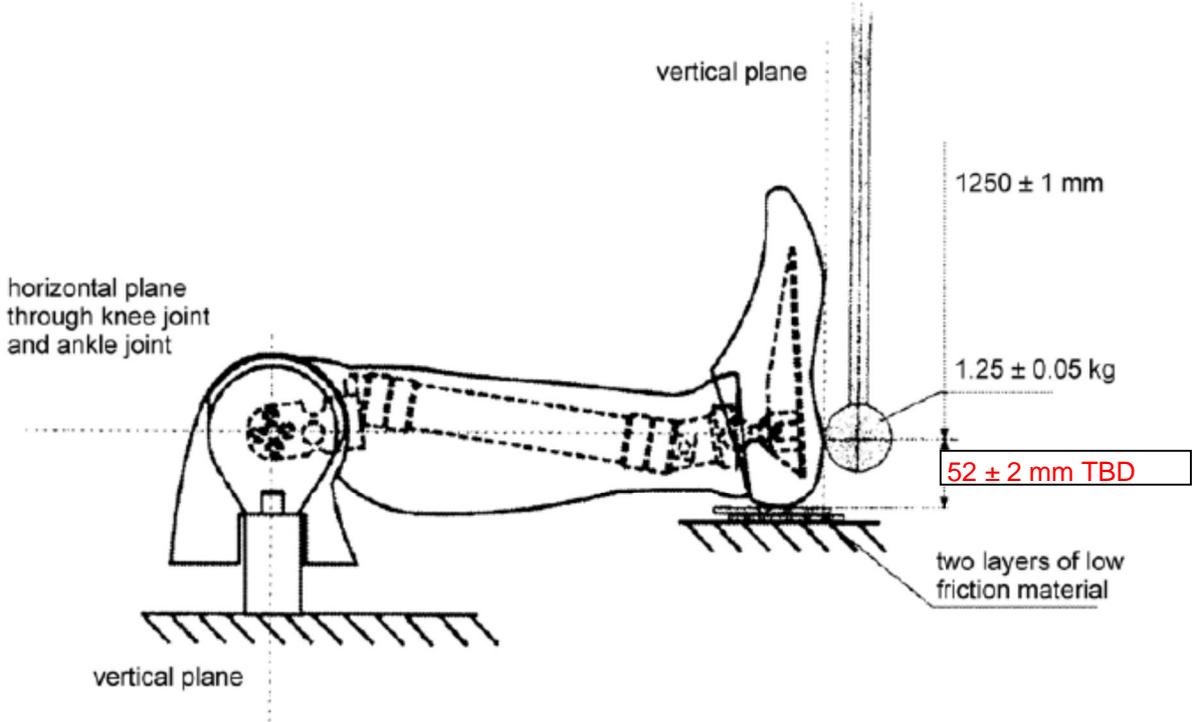


Figure 3

Lower foot impact test (with shoe)

Test set-up specifications

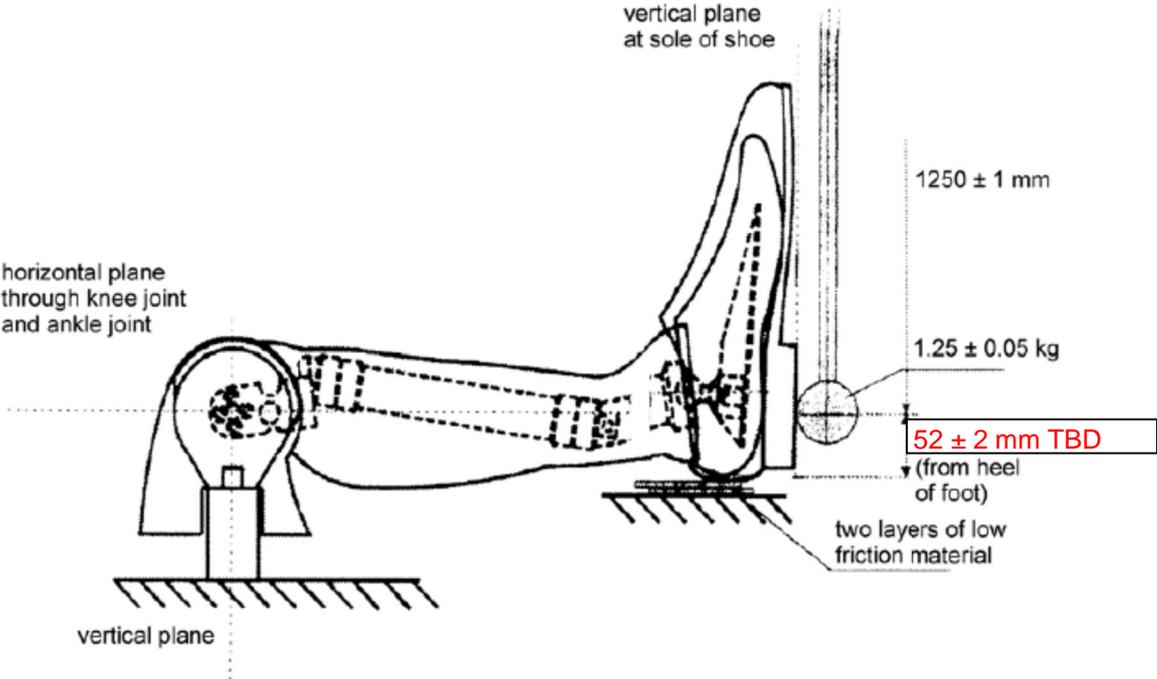


Figure 4

Pendulum impactor

Material: alluminium alloy
Mass of arm: 285 ± 5 g
Mass of impact cylinder:
 1250 ± 20 g

