Impact Exposure on High Speed Boat

How to comply with the
EU Directive on Whole Body Impact
and Vibration

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Professional rigid inflatables
Boomeranger

Purpose of study

Customers ask us:

“Do your boats comply with the EU Directive?”

We needed to know what to answer.

Background Facts

- The EU Directive states limits for allowed human impact exposure on boats.
- These limits are so strict that no rescue missions or normal military training sessions can be done without exceeding them.
- This makes the employer legally responsible for injuries caused by exposure to slamming.
- Derogations can be granted, but only when "*the best available means to reduce impact exposure*" are used.

Boomeranger's Approach

We need to:

- Supply the best possible sea keeping hull
- Show base line data for hull comparison
- Advise our customers on the best way to reduce impact exposure
- Offer the best available technologies to reduce impact exposure

Study

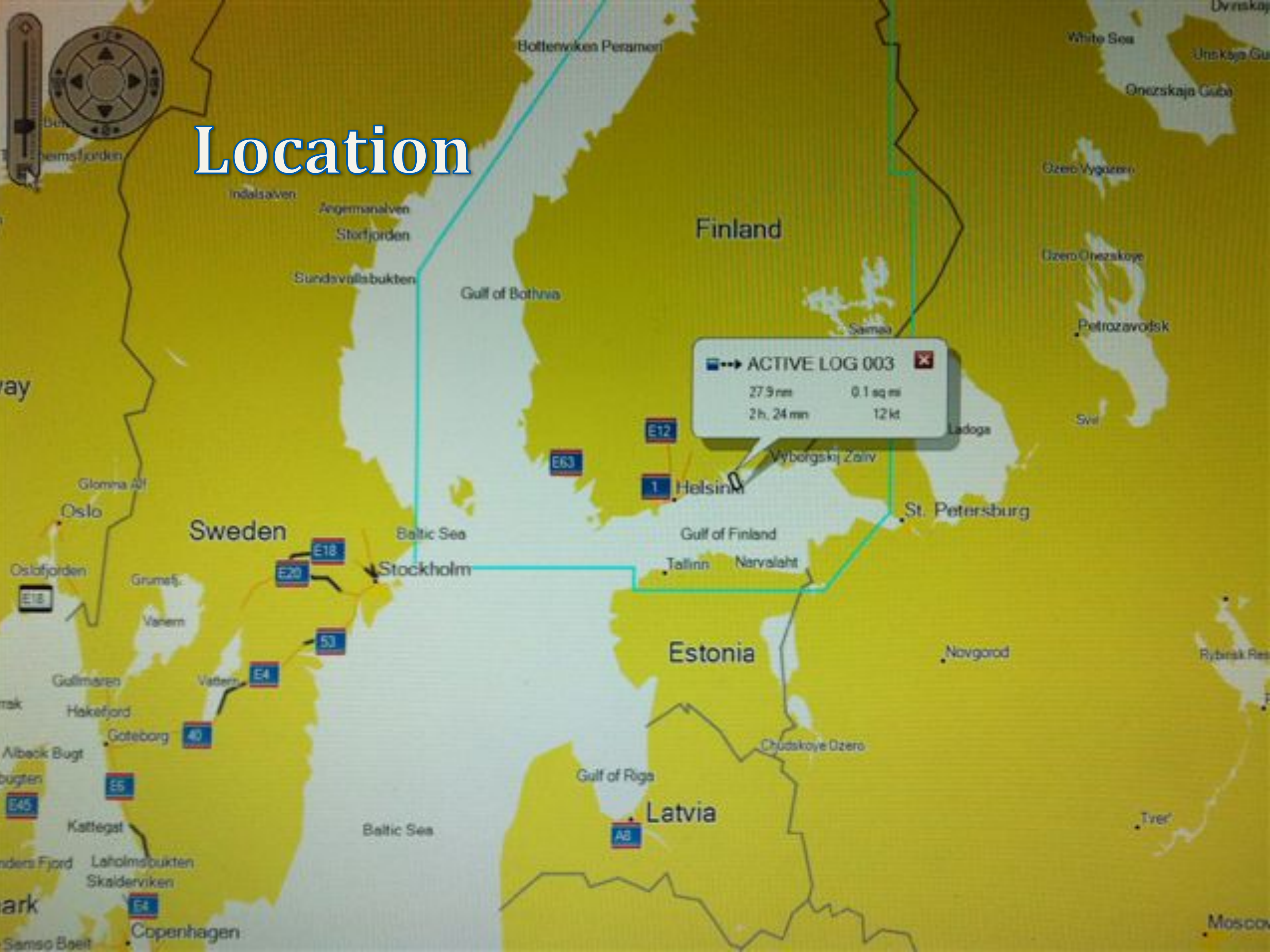
Impact measured - at speed - in high seas on a 9.8m twin outboard open RIB,

- to get base line values for comparison with other hulls.
- to measure impact exposure on two different suspension seats.

Method

- Two parallel data acquisition systems used : Valitec/Crossbow and Gulf Coast Electronics
- Deck impact measured with accelerometers placed mid-ships inside steering console
- Human impact with accelerometers mounted on kidney belts, on two subjects, seated on two different suspension seats mounted in front of the console
- High Speed filming 300fps to visualize dynamics
- Track - Speed and Heading time logged by GPS

Location


ACTIVE LOG 003
27.9 nm
0.1 sq mi
2 h. 24 min
12 kt
Finland
Sweden
Estonia
Latvia
Helsinki
Stockholm
St. Petersburg
Tallinn
Oslo
Gulf of Bothnia
Gulf of Finland
Baltic Sea
Gulf of Riga
Copenhagen
Ladoga
Novgorod
Petrozavodsk
White Sea
Goteborg
Kattegat
Skalderviken

Conditions

Dec 22

Rain

Sea State3-4

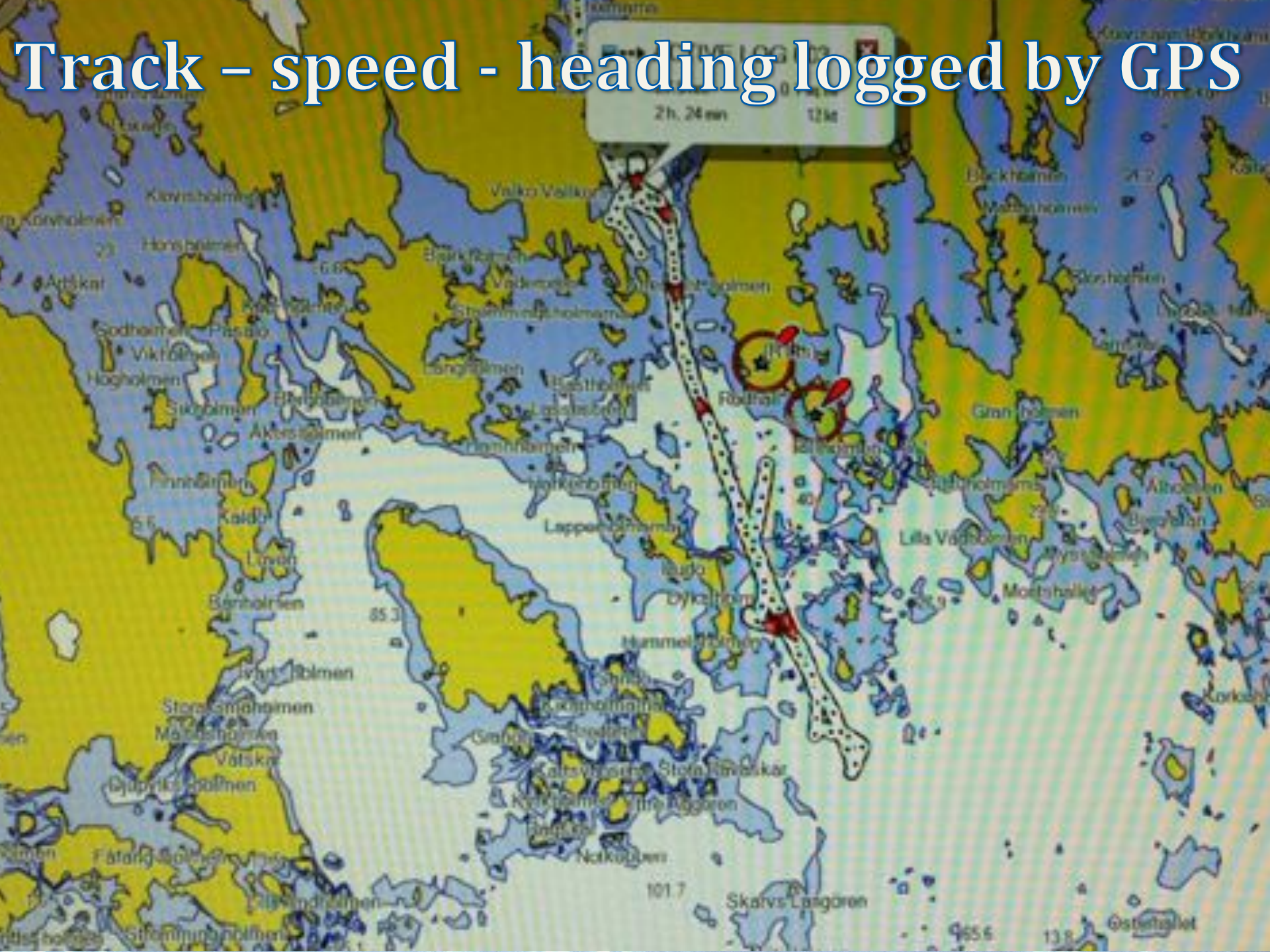
Temp 3°C

Wind 24 kts SW

Wave height 1.6m

Boat Speed 20 – 35 kts

Track – speed - heading logged by GPS



Results - Boat impacts

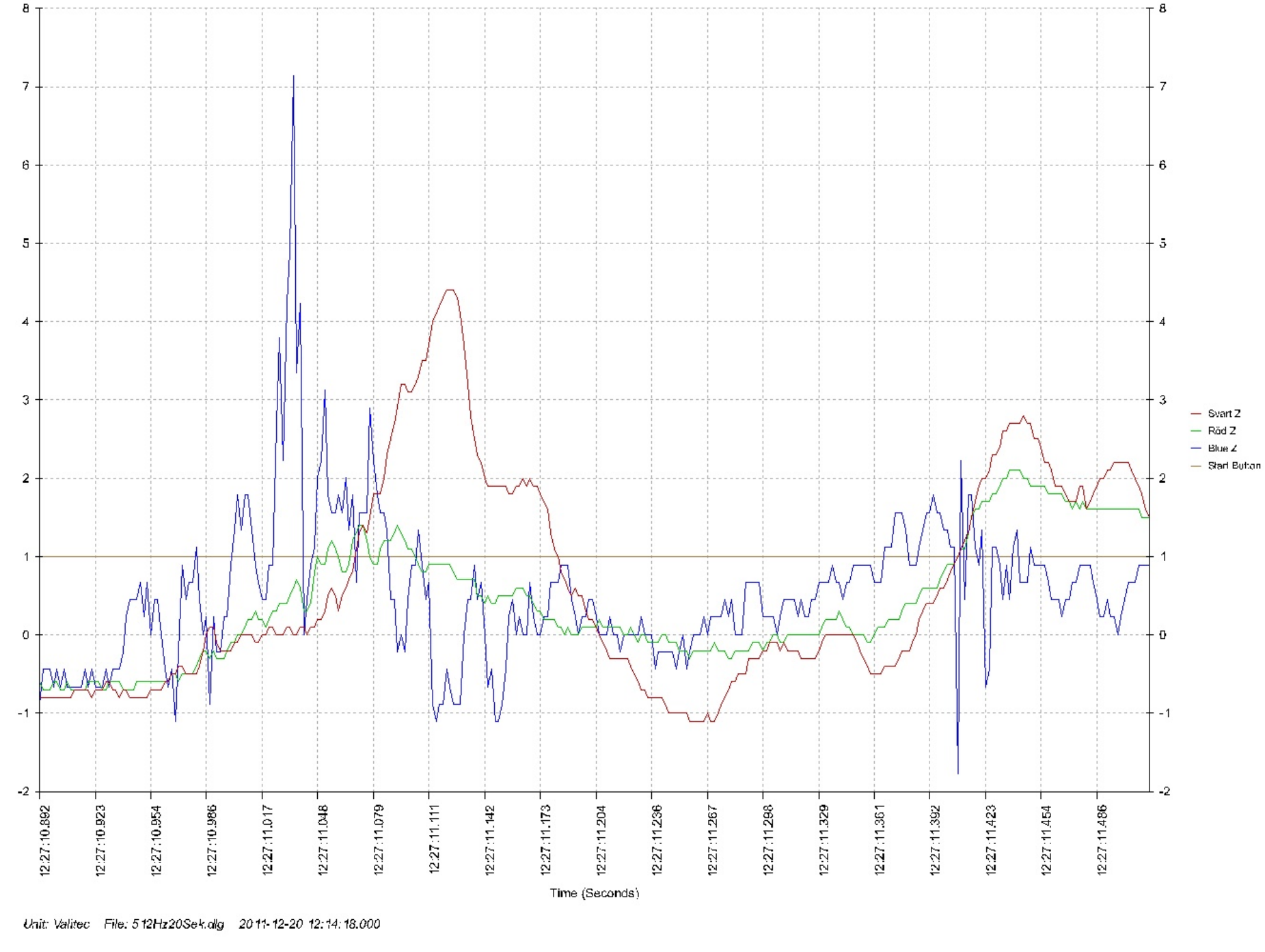
- Boat impacts showed maximum peak value of 7.13g on Valitec system
- Sed8 value from GCS System 2.84

Results - Boat impacts

The Sed8 value 2.84 MPa

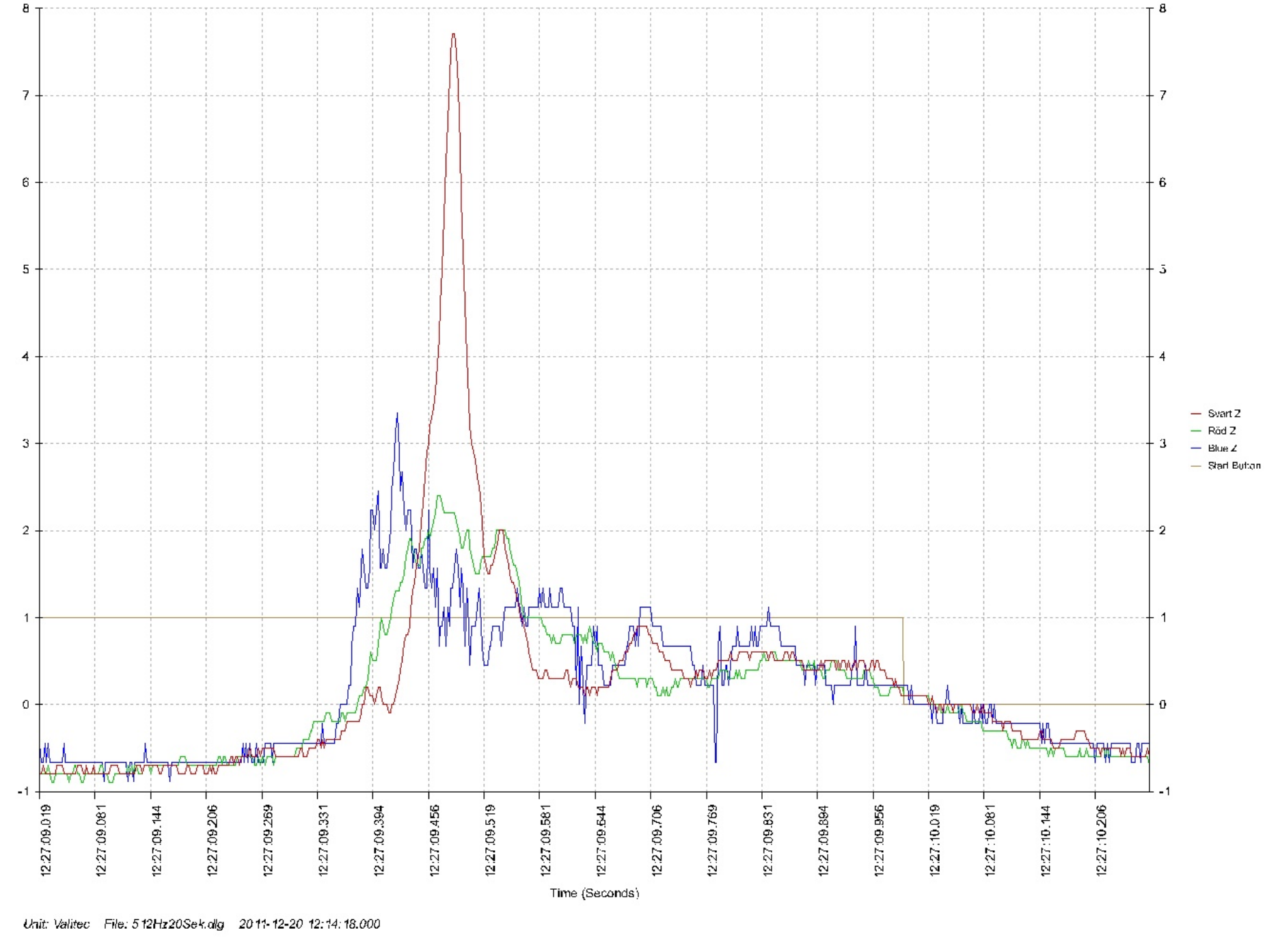
This is significantly lower than 4.7 MPa
- the limit of suggested by the US Navy.

"A human exposure for accumulated spine stress dose normalized to an eight hour exposure (Sed8) is expected to be no more than 4.7MPa. ….. Sed8 values shall be based on ISO 2631 Part 5 Health Hazard Assessment for Repeated Impacts."



Unit: Valitec File: 512Hz20Sek.dlg 2011-12-20 12:14:18.000

Results – Human impact exposure



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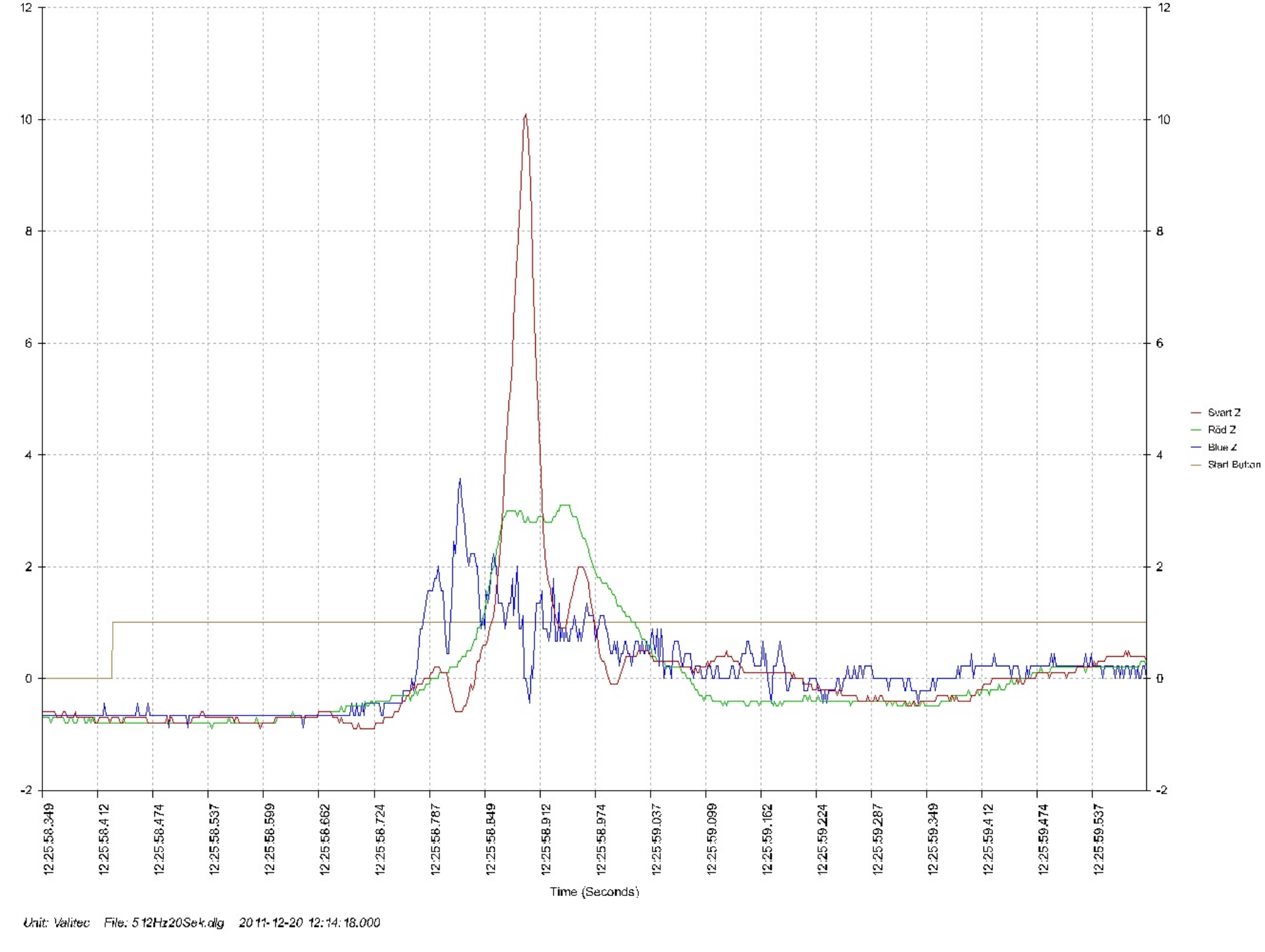

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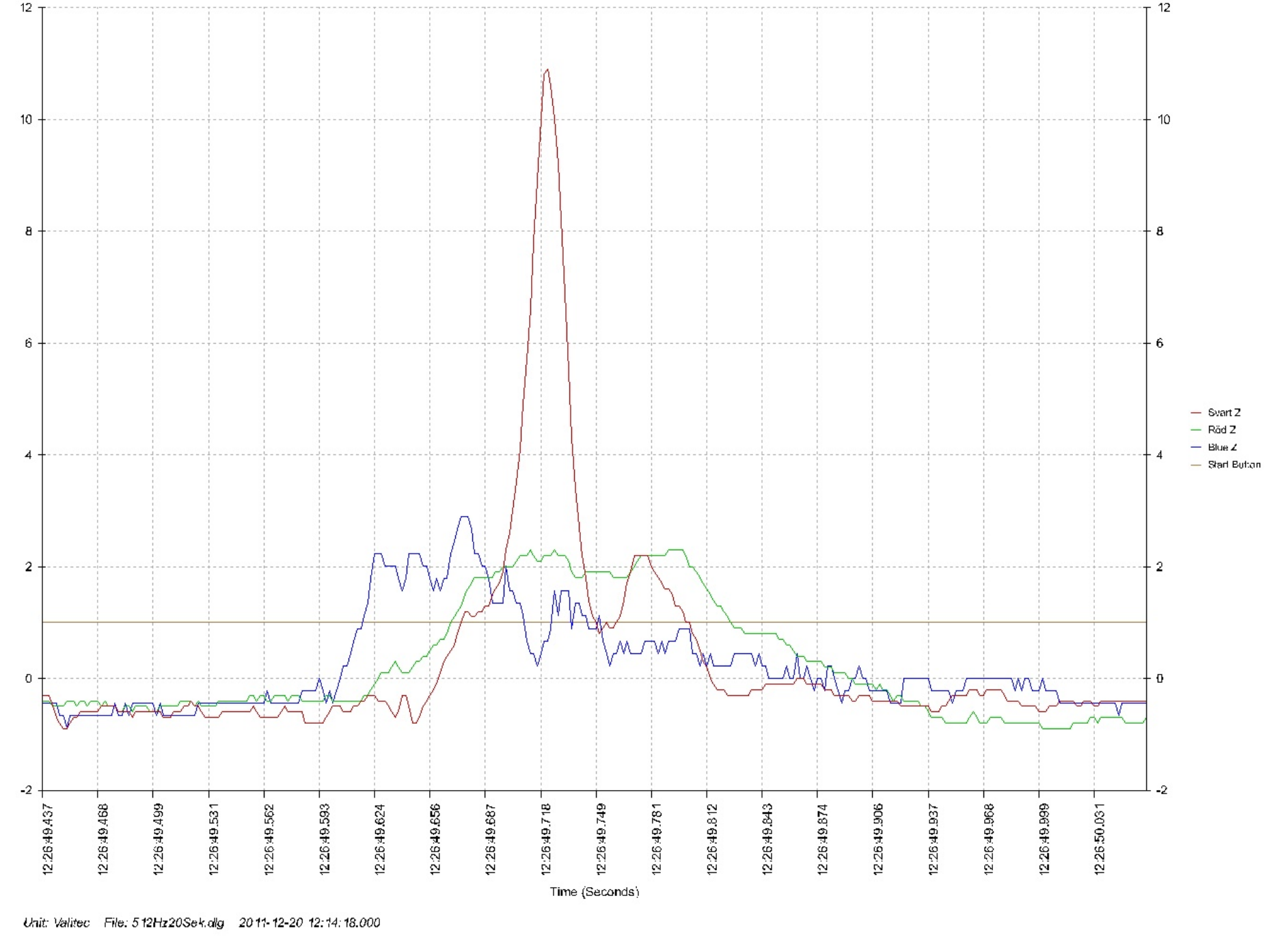
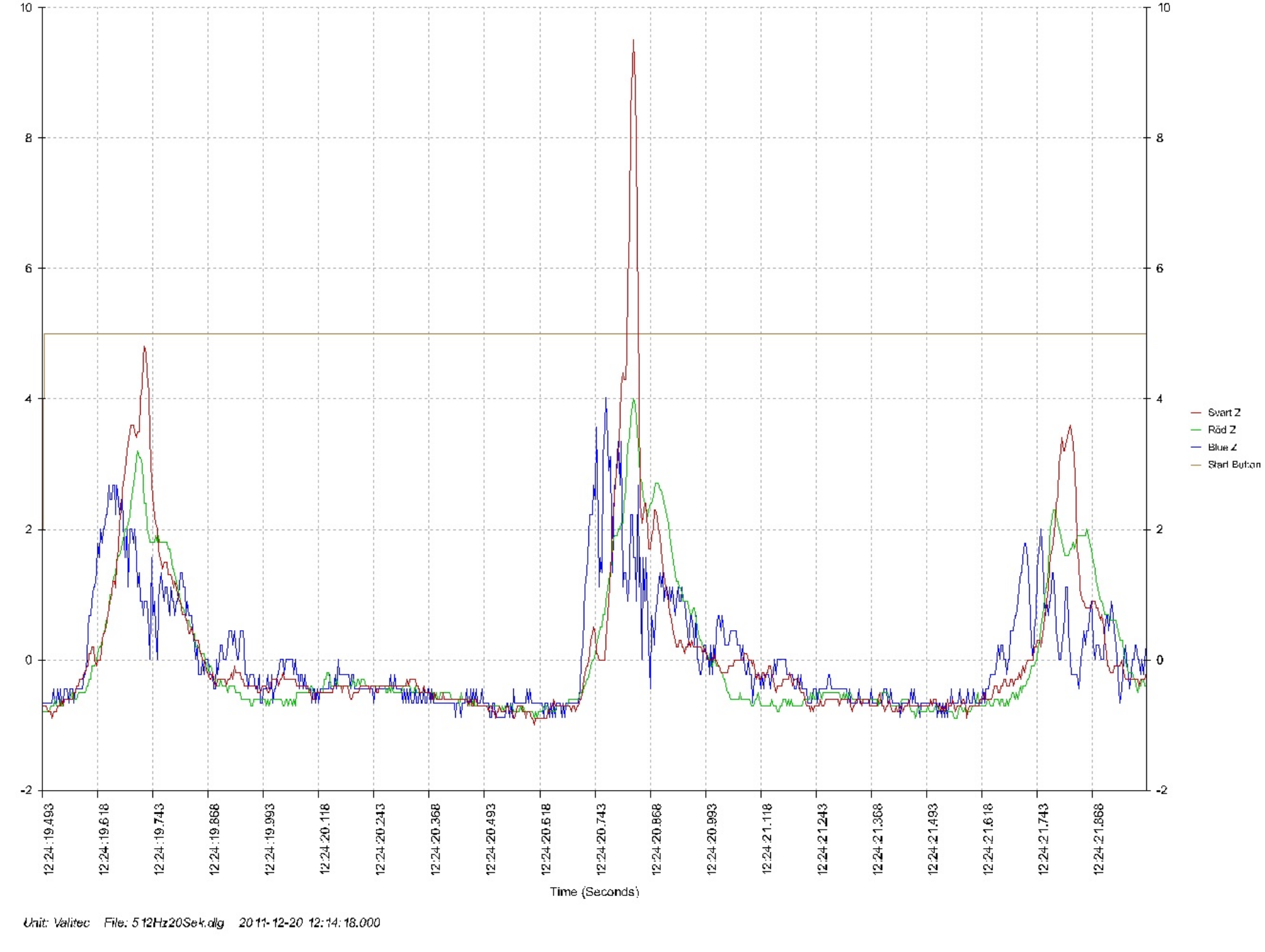
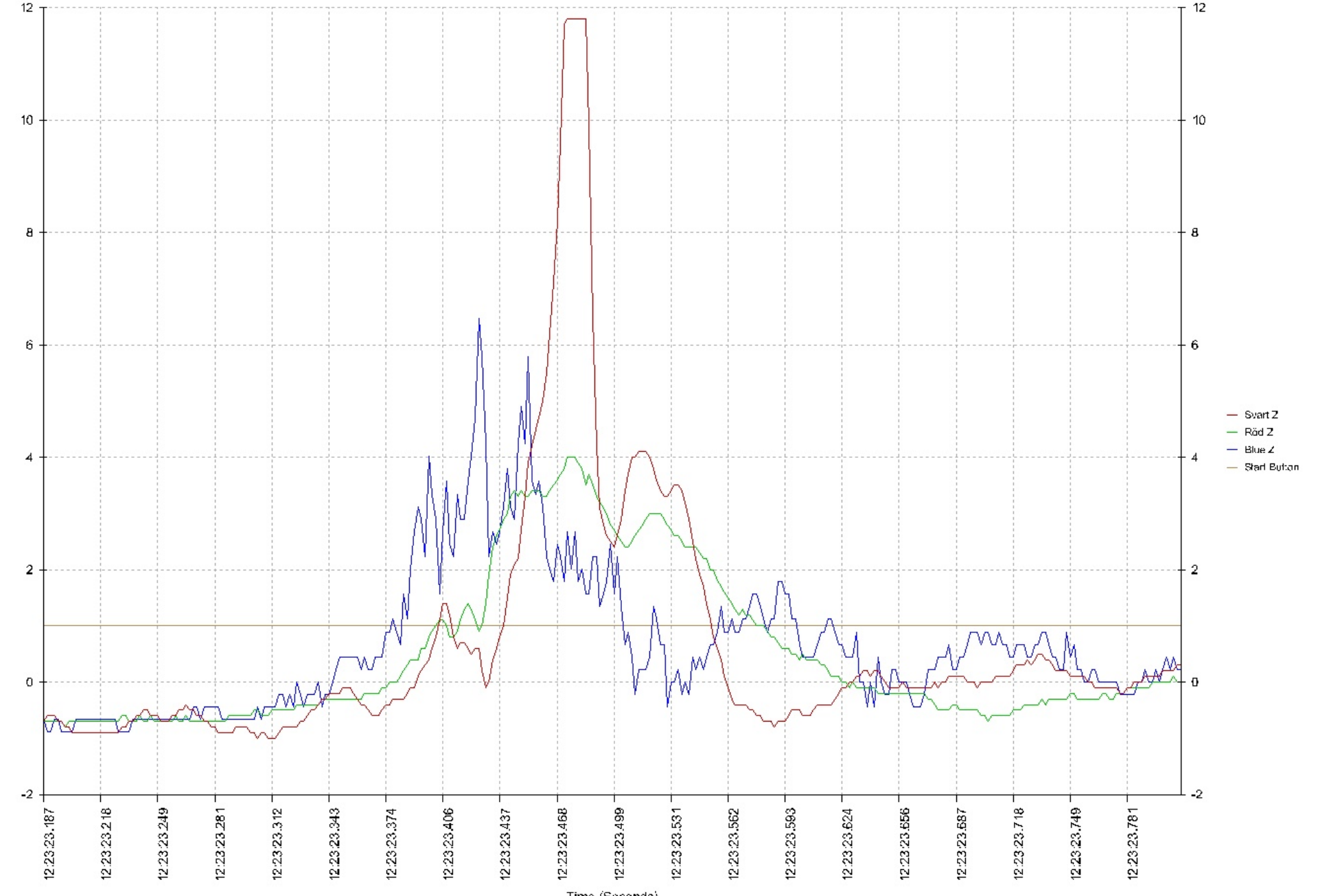


Unit: Valitec File: 512Hz20Sek.dlg 2011-12-20 12:14:18.000

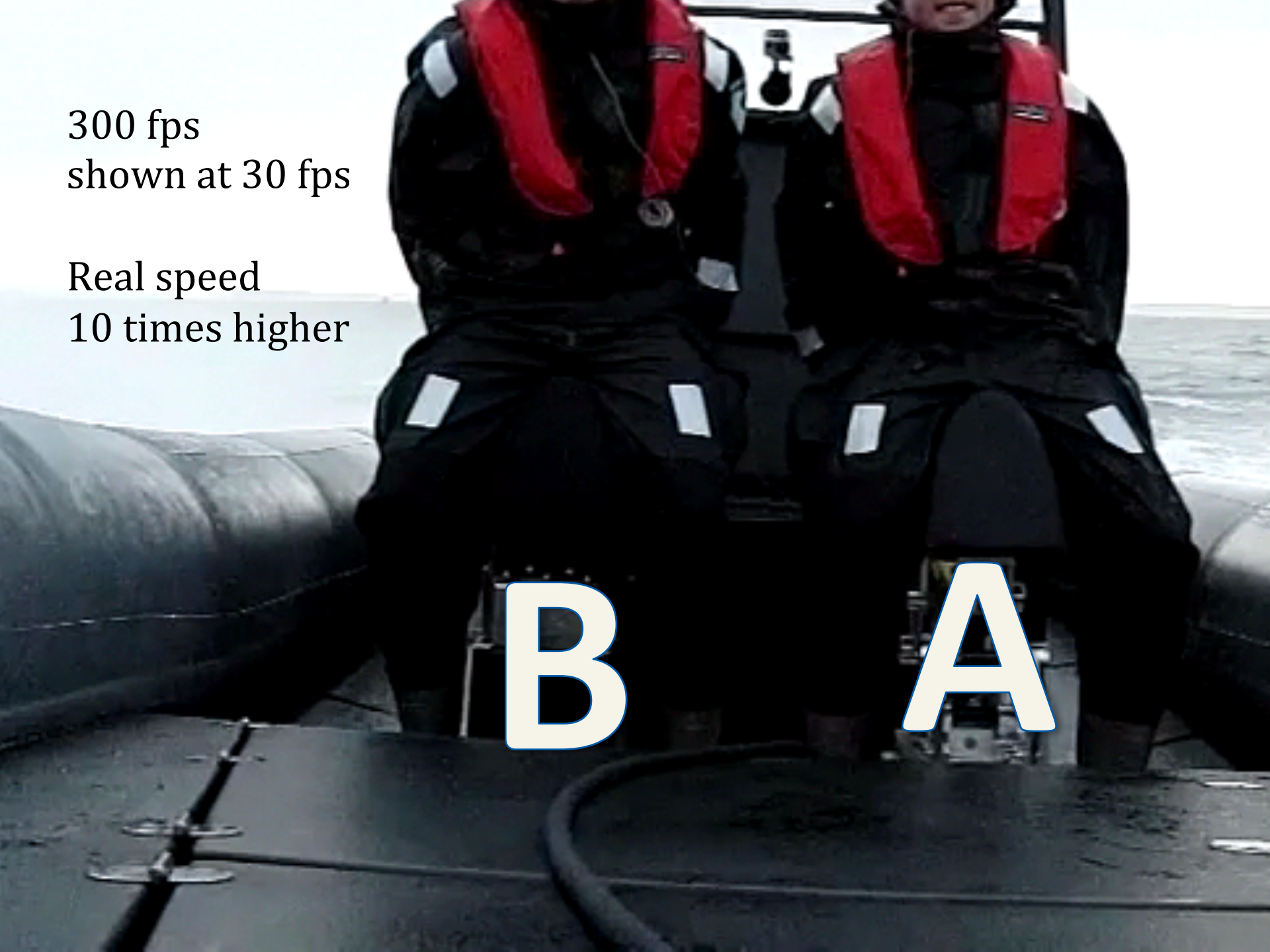


Unit: Valitec File: 512Hz20Sek.dlg 2011-12-20 12:14:18.000


12
10
8
6
4
2
0
-2
Svart Z
Röd Z
Blue Z
Start Button
12:23:23.187
12:23:23.218
12:23:23.249
12:23:23.281
12:23:23.312
12:23:23.343
12:23:23.374
12:23:23.406
12:23:23.437
12:23:23.468
12:23:23.499
12:23:23.531
12:23:23.562
12:23:23.593
12:23:23.624
12:23:23.656
12:23:23.687
12:23:23.718
12:23:23.749
12:23:23.781
Time (Seconds)

Results - Human impact exposure

- Seat **A** showed maximum peak values of **11.8g** (max value for Valitec/Crossbow device)
- Seat **A** repeatedly **multiplied exposure** on human to over **3 times higher** than deck/hull impacts
- Seat **B** showed maximum peak value of **4.0g**
- Seat **B reduced exposure** on human
  - More reduction the higher the impacts.


300 fps
shown at 30 fps
Real speed
10 times higher
B
A

Analysis

A significant difference in impact exposure between the seats, (3 times) is explained by Seat A bottoming out (reaching bottom of its stroke).

Analysis of HS films shows that seat A stops abruptly at the end of stroke.

Conclusions - Boat

- Boat impact values are good.
- Comparisons against other hulls should be done by simultaneous side-by-side testing.

However

- Even the best sea-keeping hull cannot guarantee impact exposure complying with the EU-directive.

Conclusions Seats

- Seat B showed significant reduction of exposure especially in the higher range impacts.
- Seat A showed significant multiplication of exposure especially in the higher range impacts.
- Seat A creates a significant increase in exposure and thus risks of injury, limiting operations.

Conclusions

Just fitting any “suspension seat” is not sufficient. - That can even be dangerous.

In view of the EU-Directive’s demand for “best available technology” only Seat B can be considered for professional use.

Optimized hull shape and proven - efficient suspension seating is needed.


Thank you
Professional rigid inflatables
Boomeranger

Limitations

- Speed was limited by discomfort on test subject.
- No handholds were mounted in front of the seats.
- GCS can record for hours, but graphs can not be overlaid due to separate time skips.
- Valitec system has limited data sampling size.
- Deck accelerometer was mounted 1,5 m behinds the seats, so transfer functions can not be calculated.

Notes

- Crossover study design – both subjects used both seats
- Subjects were of equal size and stature ≈ 80kg body mass, 180cm
- Seat A was tested at its highest resistance and highest suspension travel setting
- Seat B was tested at standard height with non-adjustable damper