

ETPC Sledge Modifications – January 2008

This document is a collection of Word Document, e-mails, Excel Spreadsheets, PDF files and images sent by Jan Buitenhuis of the ETPC between November 2007 and January 2008 sorted into chronological order. The final four images were taken at Zwolle (NL) in January (19th) by Sascha of Pullingworld.

The original e-mails, with attachments, were sent by Jan to all the national Tractor Pulling bodies in Europe.

As far as I am aware these are all the document issued electronically by the ETPC between early November 2007 and January 2008 relating to Sledge modifications to be made in the wake of the Great Eccleston incident in August of 2007. I cannot accept any responsibility for any omissions or errors contained in this compilation.

Mark Gass-Brown (Squirrel), 8th February, 2008

REPORT: SLED INSPECTION SLED 1007, MIGHTY CHALLENGER

Date inspection: 27th October, 2007
Location at: Sled owner, Mr. Andrew Blake's workshop

Persons present from ETPC:

- Matthias Muensinger SIT
- Clemens Wellink SIT
- Jan Buitenhuis ETPC

Persons present in UK:

- Karl Carter North West Tractor Pullers/BTPA
- Andrew Blake Sled owner
- Not available Sled operator

Sled 1007 has been build in the early 90s by Mr. Graham Stone.
Today's owner: Mr. Andrew Blake.

Basic principles of the sled:

- Many functions, air operated.
- Many air functions have spring loaded chambers; that means with air pressure= disengaged, no air pressure = engaged .
- Drive train to box:
 1. Shaft comes out of wheel driven axle into a pinion of a smaller axle fitted in the rear with a function as a part of the transmission for box travel
 2. This extra axle has on 1 side a sprocket for box drive, other side a brake on the (former) wheel drum.
 3. During pulling this axle is pinion driven, 1 side is brake activated, so driveline goes through differential and then the sprocket is driven for driving the box.
 4. After this axle, gearboxes are following and the main clutch in the system
 5. Finally driving the front shaft in the transmission where a one duplex box chain is fitted on.

According to the ETPC investigations on the spot and other information gathered, we assume the following has happened during the tragic run with Popeye tractor on August 26th 2007

- Before the run the box has been reloaded, no gear change.
- After the accident the transmission was also still in gear.
- No malfunction of the clutch can be found.
- During the run, sled operator took several actions and at about 20mtr. red light shows.
- Sled operators' actions don't show much results on the sled.
- The rope of the kill switch was not pulled.
- Box rips off the front board and box is landing on Popeye tractor.
- After accident front board shows old hidden cracked welding and a hidden cracked plate.

ETPC conclusion:

- **ETPC has a thought what the failures may have been, but this is not a statement of facts, but based on our best deductions, as the sled has a prohibition notice on it by the “Government Body” which prevents it from being dismantled and as a lot cannot be proven due to the many damaged items.**
-
- 1. Failure box travel may be caused by a failure of the air activated drum brake at the axle in the drive train. **“Pneumatic Failure?”(or other internal failure in drive train)**
This is impossible to determine at this time due to the restrictions on the sled.
- 2. Sled operators’ actions don’t show in any result of the kill switch. Probably **“Pneumatic Failure”**. The wheel brakes would appear to have been operated as at no point in the run does the “sled chain” become slack between tractor and the sled.
- 3. Breaking of the front plate: **“The whole construction had been sheared by the force.”**

On behalf of ETPC,

Jan Buitenhuis

Date of drawing up this report: 30st October 2007

Thursday 08Nov02

Dear friends,

First: ETPC members please send the previous mail and this mail to your sledowners !!

Following the outcome of the formula with the high forces on the front of sled ETPC daily board has decided the following:

- **From today ETPC tractors (All Mod, SS and PS)cannot run in front of a sled who is not modified with strong frontend and the right shock absorbers.**
- **Uphill sledges are forbidden.**
- **No sleds allowed with boxwheels running on top of chassisbeans.(was already decided for 2008)**

Regards,

On behalf of the ETPC

Jan Buitenhuis.

Thursday 08Nov07

Dear friends,

Situation for this moment.

You have seen recently a report of our investigations in the UK.

After receiving a formula to calculate the forces in the sleds, we checked and double checked this formula by different parties and this formula is correct.

What do you have to fill in the formula:

1. Total weight of box.
 2. Speed of box.
 3. Stroke of the buffers.
- To calculate the weight of the box is not a problem, most of them are between 10-12000 kg.
 - Speed of the box. In Bettborn we measured the speed of the tractors, max.43 km/h in the SS. You can assume that when the boxdrive doesn't work speed will be higher. When a tractor stops with a flying box, tractor and sled stops but the box has its energy and wants to keep its speed to the ground, also with a downhill chassis the box can even accelerate to higher speed as before. This is calculated in a situation that there is a major problem in a sled and other items are failing. **We have put the max, boxspeed at 60km/h = 16m/sec.**
 - Stroke of buffers: With the 2 figures from above: 12000 kg by 16m/s and for example buffers with a stroke of 9 cm gives an impact of 1700 tons.
 - As soon as you increase the stroke to 25 cm, the impact is 600 tons.
 - **SEE ATTACHED FORMULA, you can change the figures and you will see the result.**
 - At this moment we think probably 600 ton is the max, or if a sled owner can prove by official papers, that his construction of the front is stronger, then the stroke can be made shorter
 - Shockabsorbers should be fitted in the centre of the gravity point of the weightbox, so in horizontal view in the middle of the box.
 - Which shockabsorbers have these stroke of 25 cm and can hold 300 ton each by an impact of 16m/sec?
 - Hydraulic shockabsorbers, huge ones can hold 150 tons each, but a stroke of 25 cm gives a total length of 65 cm and you have to use 4 of them. Additionally you must use rubber blocks to avoid hammer effect.
 - To reduce length you can turn around the cylinder, fix the solid part of the cylinder inside the weightbox and only the stroke part of 25cm is sticking out at the front.
 - Deforming tubes: Can only be used one time, after that it is trash. Kamiel Stuer is working already for weeks on this system and he will probably be the first who has a system ready with deforming tube. Total length deforming tube 40-45 cm + rubber buffer. The day before yesterday I heard from a different system of deforming tube but that is not tested at all.
 - So what options do we have: 4-6 hydraulic cylinders, system Kamiel (ready in 1-2 weeks?)
 - **So you can think already at the following: Do I choose for hydraulic or deforming tube(=cheaper).**
 - **Do I have to extend my frame or frame+pan?**
 - **Do I built it partly in the weightbox?**
 - **Who can calculate the strength of my front of the sled?, mandatory!**

If you any questions about this part don't hesitate to contact ETPC or SIT

Regards,

Jan.

Krachten berekening Balastbak

Snelheid bak	16	m/sec
Gewicht bak	120000	N
Lengte buffer	0.25	meter

Speed
 Weight Box
 Stroke Buffer

t	0.03125	sec
Remvertraging	-512	m/sec ²
Kracht op kopschot	-6262996.942	N
Krachten in Tonnen	-638.4298616	ton

Force at front sled

Calculation of impact force on sled front end in case of flying weightbox

Objective: calculation of the forces generated by a flying weightbox in case all safety devices fail

Development of the reasoning by Benno Kramer¹, Trecker Treck Edeweicht e.V / Red Shadow Team.
Calculation example based on the STUER-EGGHE sled Stille Genieter before the 2008 transformation

1) Definition of a Worst Case Scenario

To create a max. possible weightbox speed following things must happen:

- a) During the acceleration phase of a pull something in the driveline of the weightbox breaks.
- b) The box movement control doesn't work.
- c) The sled operator does not react before the box slams back into the rear position and the tractor gains a high speed.
- d) The sled operator applies the kill switch
- e) The tractor shuts down immediately.
- f) On the sled push down is activated, tire brakes are applied.
- g) The driveline brakes and the brakes at the weightbox itself don't work.

This scenario leads to a maximum slow down of the sled and also of the tractor. This causes a **maximum speed difference between the sled and the freewheeling weightbox** on it.

2) General thoughts

The sled can't stop itself in just a moment but does brake with its max. braking force. It has to slow down its total weight, less weightbox and weights and additionally the tractor.

A sled can only create as much braking force as it creates to stop a tractor.

Tests carried out in November 2007 by Stuer-Egghe and Peter de Regt confirm the statement of Benno Kramer that a sled has a braking force which is approx. equal to the total weight of the sled.

This means that a 24 tons heavy sled can generate 24 tons braking force.

3) Calculation of the maximum speed difference between flying weightbox and decelerating sled

Applied to the STUER-EGGHE sled Stille Genieter before the 2008 transformation:

Empty sled weight (without weightbox)	11,5 T	Or:	Fixed weight	13,0 T
Weightbox weight	1,5 T		Mobile weight	11,5 T
Max weight in weightbox	10,0 T		Tot. weight	24,5 T
Extra front end weight	1,5 T			
Total max weight	24,5 T			

4) Deceleration of sled and Tractor during the flying box phase:

In this calculation we assume the max. braking force is present in any position of the weightbox even the tyres create less resistance than the pan.

¹ Benno Kramer: Thoughts and calculation of weightbox speed in case of sled malfunction.doc, e-mail 15/11/2007

$$F = m \cdot a \rightarrow \boxed{a = F / m}$$

a = deceleration [m/s²] to be calculated
 F = brake force [kN] 245 kN
 m = weight [kg] 13.000 kg sled + 4.500 kg tractor = 17.500 kg

$$a = 245.000\text{N} / 17.500 \text{ kg} = \mathbf{14,0 \text{ m/s}^2} = \text{max deceleration of sled + tractor}$$

Box speed when it hits the front end of the sled:

The box tries to keep the speed it had at the moment the kill switch was applied. At this moment the box speed and sled speed are the same. Then the sled starts slowing down while the weightbox keeps its speed. Consequently the weightbox catches up with the sled at a speed of:

$$\boxed{\Delta v = \sqrt{2a \cdot \Delta s}}$$

Δv = Impact speed of box against front end [m/s] to be calculated
 a = deceleration [m/s²] 14,0 m/s²
 Δs = Box travel length [m] 4,67 m (Stille Genieter)

$$\Delta v = \sqrt{2 \cdot 14,0 \text{ m/s}^2 \cdot 4,67\text{m}} = \mathbf{11,4 \text{ m/s}} \text{ (41 km/h)}$$

Notice that a higher sled speed will not cause a heavier impact because when the box hits the front end the sled still has some speed.

Example: suppose $v = 16 \text{ m/s}$ (in stead of 11,4), then the box will still hit the front end after 4,67m at a relative speed of 11,4 m/s because at that moment the sled still moves at 4,6 m/s.

5) Calculation of the impact force of the flying weightbox against the forward buffer

At the collision the energy of the box is transferred to the buffer at the front end of the sled. The impact force depends on the working length of the buffer

A primary condition however is that the **impact force remains constant over the buffer working length**, which is not the case with rubber buffers.

$$\boxed{F = E / L}$$

F = impact force [kN] to be calculated
 E = Energy of the flying box [kJ]

$$\boxed{E = \frac{1}{2} m \Delta v^2}$$
 m = mobile mass [tons] mass of the box + weights
 Δv = impact speed [m/s] speed of the box against front end
 L = working length of the buffer [m] 0.5 m in this example

$$F = \frac{1}{2} \cdot 11,5 \cdot 11,4^2 / 0,5 \text{ [tons m}^2\text{/s}^2 \text{ / m]} = 1.504 \text{ kN equiv. } \mathbf{150 \text{ ton}}$$

This is the force the buffer must sustain during the buffer working length, and equally the force needed to fix the buffer on the sled.

To enable the participants to carry out the calculations for their own individual case, an Excel calculation sheet has been made available:

Calculation of impact force on forward sled frame in case of flying weightbox.xls

Calculation of impact force in case of flying weightbox

For background and explanation see the document

Calculation of impact force on forward sled frame in case of flying weightbox.pdf

Regarding the calculation tables:

input data values to be entered manually
 output data calculated automatically

Calculation examples based on the STUER-EGGHE sled Stille Genieter before the 2008 transformations

STEP 1 Calculation of maximum deceleration

formula:

a = F / m		
a = deceleration	[m/s ²]	to be calculated
F = braking force	[kN]	take the total weight of the sled including weights, expressed in kN (1 ton = 10 kN)
m = fixed mass (weight) of the sled + tractor	[tons]	take the weight of the sled excluding weights and weightbox, i.e. only fixed weight + tractor

calculation table:

fill in:		
F = weight of the sled expressed in kN	245	[kN]
weight of the sled excluding weights and weightbox	13.0	[tons]
weight of the tractor	4.5	[tons]
result:		
deceleration	-14.0	[m/s ²]

STEP 2 Calculation of the maximum speed difference between flying weightbox and decelerating sled

formula:

$\Delta v = \sqrt{2a * \Delta s}$		
Δv = speed difference	[m/s]	to be calculated
a = deceleration	[m/s ²]	already calculated in STEP 1
Δs = travel length of the weightbox	[m]	travel length of the weightbox, from rear start to first obstacle, mostly the buffer on front frame

calculation table:

fill in:		
a = deceleration	-14.0	[m/s ²]
Δs = weightbox travel length	4.67	[m]
result:		
Δv (speed difference)	11.4	[m/s]
	41	[km/u]

STEP 3 Calculation of the impact force of the flying weightbox on the forward buffer

a) Calculation of the energy

formula: $E = \frac{1}{2}m\Delta v^2$

E = energy of the weightbox	[kNm]	to be calculated
m = flying mass	[ton]	mass of the weightbox + weights
Δv = speed difference	[m/s]	already calculated in STEP 2

calculation table:

fill in:		
m = flying mass	11.5	[tons]
Δv = speed difference	11.4	[m/s]
result:		
E = energy of the weightbox	752	[kNm]

b) Calculation of the impact force

formula: $F = E / L$

F = collision force	[kN]	to be calculated
E = energy	[kNm]	already calculated in STEP 3 a)
L = working length of the buffer	[m]	to be determined by design

calculation table:

fill in:		
E = energy	752	[kNm]
L = working length of the buffer	0.50	[m]
result:		
F = collision force	1,504	[kN]
	150	[tons]

Friday 30Nov07

Sent: Friday, November 30, 2007 10:25 PM

Subject: Fw: damper

Dear friends,

See attached files for another type of shockabsorber.

The first 10 cm is elastic damper, so for normal use, after that you have an additional 20 cm deforming tube.

So this system is 2 in 1 with a total max. stroke of 30cm.

Total 2 cylinders, 1 on each side !!

We think this is a very good option!

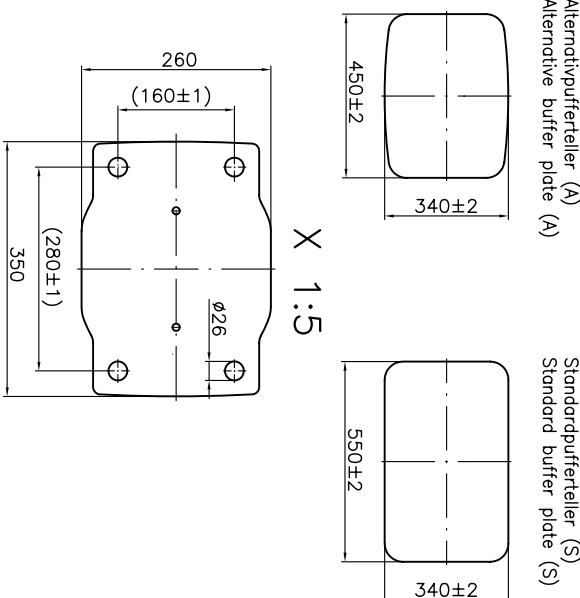
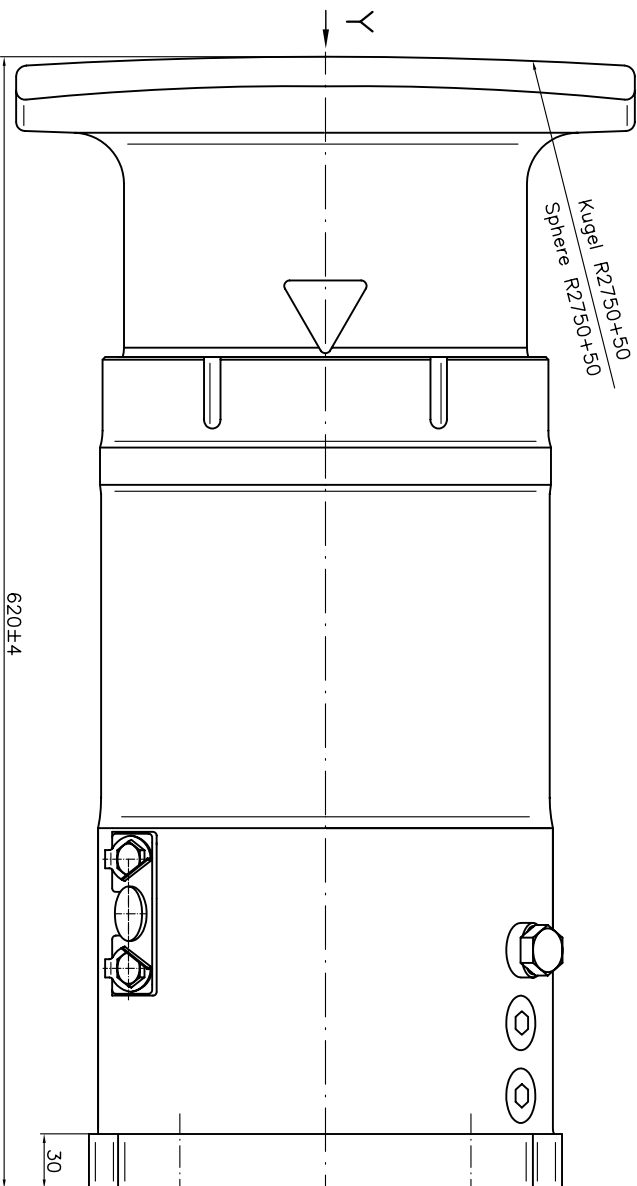
In the attachments, 2 files measurements + 2 files of the shockabsorber, 1 before and one after a crash.

For mor info contact Benno Kramer of Red Shadow Sled team: benno.kramer@nwn.de

Regards,

Jan.



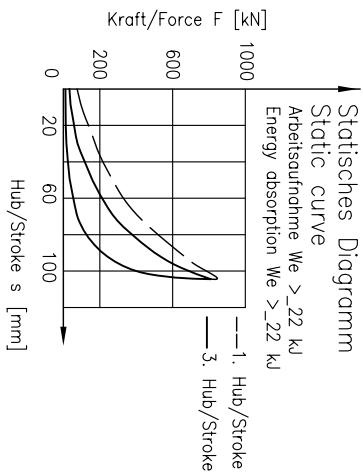


Y 1:10

Entspricht UIC 526-1
In accordance with UIC 526-1

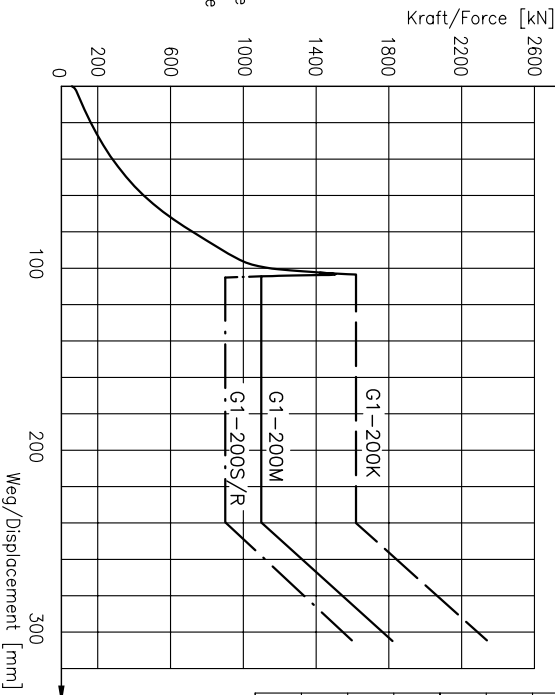
Deformationsfähige Gehäusestruktur, Verformungs-
weg zusätzlich zum Federweg: ca. 200 mm
Deformable casing provides approx. 200 mm additional
axial deflection, beyond elastic spring stroke

Farbgebung:
Hülse verkehrsrot RAL 3020
Stößel grafschwarz RAL 9011
Colour:
Casing red RAL 3020 (verkehrsrot)
Plunger black RAL 9011 (grafschwarz)



Typ. Kraft-Weg-Charakteristik
(dyn., Kollisionsgeschwindigkeit 15...40 km/h)

Typ. Force-deflection-characteristic
(dyn., collision speed range 15...40 km/h)



Typ. Teil-Nr.	Typ. Auslösekraft pro Puffer (dyn., -0/+300 kN)	Typ. mittl. Deformationsniveau pro Puffer (dyn.)	Energieaufnahme pro Fahrzeugende/Pufferpaar (dyn.)	Gewicht ca.	Puffersteller	EBA Zulassungs-Nr.
Type Part no.	Typical trigger force per buffer (dyn., -0/+300 kN)	Typical mean deformation force level per buffer (dyn.)	Energy absorption per vehicle end/ pair of buffers (dyn.)	Mass approx.	Buffer plate	EBA approval-no.
G1-200M ZCP05.06-C100000-01	1500 kN	1125 kN	600 kJ	127 kg	S	EBA 03K06A
G1-200S ZCP05.06-C100000-02	1300 kN	900 kN	500 kJ	125 kg	S	EBA 03K06B
G1-200R ZCP05.06-C100000-04	1500 kN	900 kN	500 kJ	126 kg	S	EBA 06A16B
G1-200K ZCP05.06-C100000-05	1500 kN	1650 kN	800 kJ	128 kg	S	EBA 06A16A
G1-200R ZCP05.06-C100000-06	1500 kN	900 kN	500 kJ	119 kg	A	EBA 06A16C
G1-200K ZCP05.06-C100000-07	1500 kN	1650 kN	800 kJ	121 kg	A	EBA 06A16D

Verwendbar für:
Güf, Lok

Hersteller:
EST

Teil-Nr.	Bezeichnung	Material
A	Kugel, Stoßkopf, Bohrer, ISO 2716	Stahl
B	CP0040	Stahl
C	CP0041	Stahl
D	CP0042	Stahl
E	CP0043	Schneider

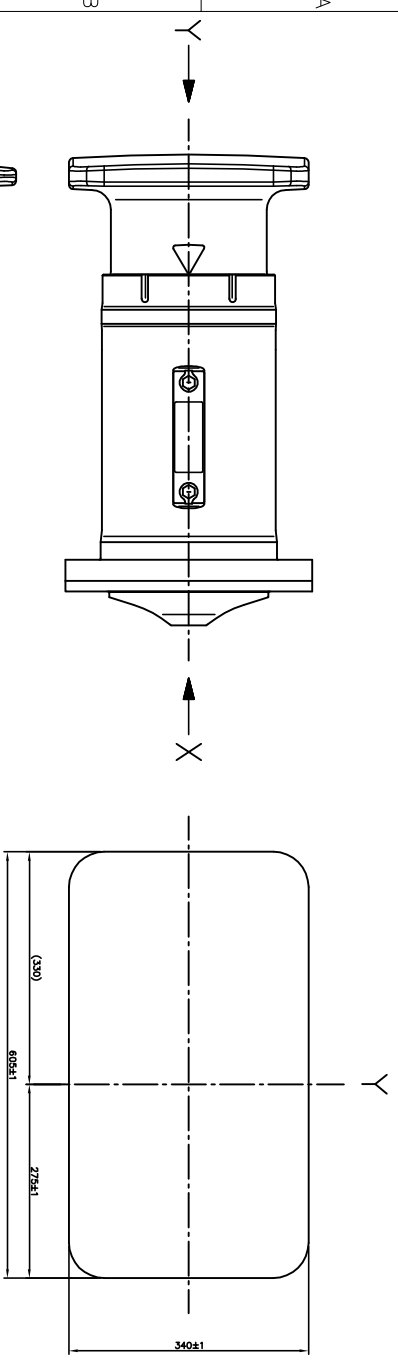
Teil-Nr.	Bezeichnung	Material
A	Kugel, Stoßkopf, Bohrer, ISO 2716	Stahl
B	CP0040	Stahl
C	CP0041	Stahl
D	CP0042	Stahl
E	CP0043	Schneider

Teil-Nr.	Bezeichnung	Material
A	Kugel, Stoßkopf, Bohrer, ISO 2716	Stahl
B	CP0040	Stahl
C	CP0041	Stahl
D	CP0042	Stahl
E	CP0043	Schneider

Teil-Nr.	Bezeichnung	Material
A	Kugel, Stoßkopf, Bohrer, ISO 2716	Stahl
B	CP0040	Stahl
C	CP0041	Stahl
D	CP0042	Stahl
E	CP0043	Schneider

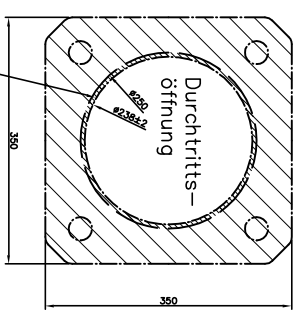
Teil-Nr.	Bezeichnung	Material
A	Kugel, Stoßkopf, Bohrer, ISO 2716	Stahl
B	CP0040	Stahl
C	CP0041	Stahl
D	CP0042	Stahl
E	CP0043	Schneider

Entwurfszeichnung, Stand 08.05.2007,
 unterliegt nicht der Änderungsverfolgung



Federstern und Abmessungen in Anlehnung an UIC 526-1
 Elastic system and dimensions related to UIC 526-1
 Deformationsfähige Gehäusestruktur, Verformungs-
 weg zusätzlich zum Federweg: ca. 350 mm
 Deformable casing provides approx. 350 mm additional
 axial deflection, beyond elastic spring stroke
 Farbgebung:
 Hülse tiefschwarz RAL 9005
 Stängel großflächenschwarz RAL 9011
 Colour:
 Casing black RAL 9005 (tiefschwarz)
 Plunger black RAL 9011 (großflächenschwarz)

Schnittstelle zur Fahrzeugstruktur



Bereich der Kräfteleitung,
 Hinterstützung durch die
 Fahrzeugstruktur erforderlich

* Tolerierung
 DIN ISO 8015

Typ Teil-Nr.	Typ Part no.	Typ Material pro Pulver (g/m ² - +300 kg)	Typ mittl. Anzahl Fahrzeuge/ Pulver (g/m ²)	Typ Energie- inhalt Fahrzeuge/ Pulver (g/m ²)
G2-100 MB	ZSP02.06-C100000-01	1500 kJ	1300 kJ	ca. 950 kJ
G2-100 SB	ZSP02.06-C100000-02	1500 kJ	1000 kJ	ca. 750 kJ

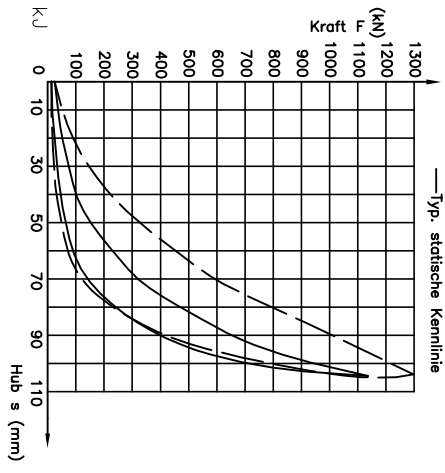
▼ Änderungen zu vorherigem Zeichnungsstand

Übersicht	Klassifizierung	Reihen	Bezug
	Klassifizierung 1:5		ca. 180 kg

Datum	Name	Bezeichnung
08.05.07	08.05.07	SUPRAPUFFER
08.05.07	08.05.07	G2-100 MB / SB

Norm	Bezeichnung
EN 150 912 II B	
EN 230 F 10	
EN 230 I 1	
EN ISO 19820 BF	
EN ISO 2253	
EN 2587 - BIC	
EN 30042 - BIC	

Blatt	Blatt
01	01



— Typ. dynamische Kennlinie
 — Typ. statische Kennlinie

Elastomer-Federsystem 50 kJ

Thursday 10Jan08

Dear ETPC members,

Most things are said before, we will say it again.

Following the calculations as send around, sleds have to be approved and caculated by an engineers office.

See also points below:

1. The new rule with shock absorbers is for minipuller sleds as well.
2. All ETPC Sled classifications will be dropped down and will be re-organised.
3. All sleds must fullfill new shockabsorber rules before first competition.
4. All sleds must be proven by ETPC to get any license back.
5. Electronic box control is mandetory as well(Is this a good thing or not?????)
6. All uphill sleds are forbidden.(Give also explanation. Some sleds are horizontal with a lifted pan and box in the back.Thats ok, as soon as pan droppes chassis front must be lower as in the back.)
7. Rollers of box are mandetory inside chassisbeams. Rollers on top not prohibited.
8. Other rulechanges are extended to later time.
9. Before anyone is going to rebuild their sled, send caculations and drawings to the SIT(Matthias Muensing)

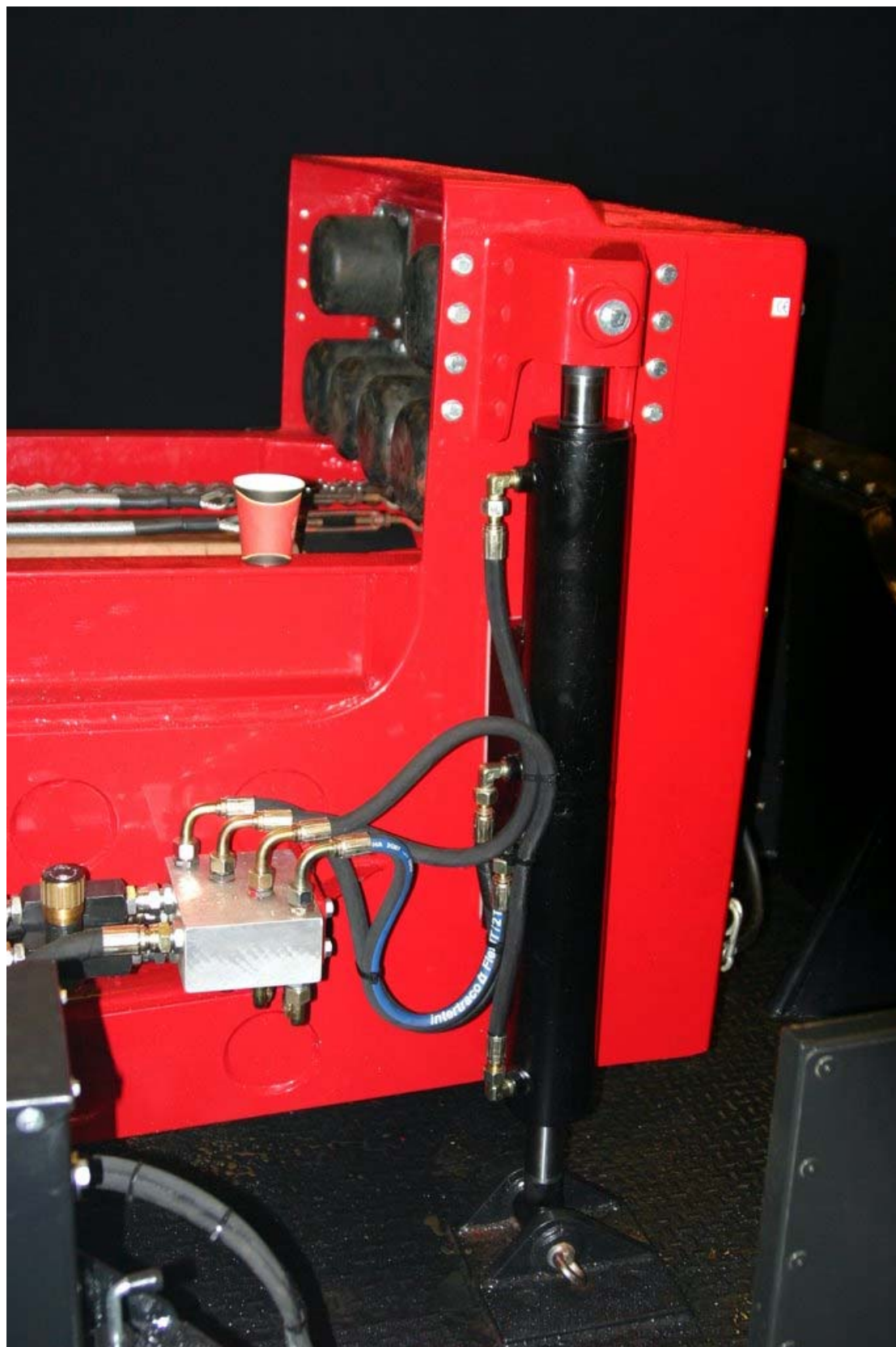
Send this to all your sledowners!!

Regards,

On behalf of the ETPC

Jan Buitenhuis.

The following photographs were taken at Zwolle (NL) in January 2008





After modification to comply with the 2008 specifications. Please note the angle of the box rails and the buffers.



The same Sledge before being modified. Note the difference in the angle of the box rails. (source ETPC web site).

