APPENDIX T-2
2015 FSAE® IMPACT ATTENTUATOR DATA REPORT

This form must be completed and submitted by **all teams no later than the date specified in the Action Deadlines onspecific event website**. The FSAE Technical Committee will review all submissions which deviate from the FSAE® rulesand reply with a decision about the requested deviation. All requests will have a confirmation of receipt sent to the team.Impact Attenuator Data (IAD) and supporting calculations must be submitted electronically in Adobe Acrobat Format(*.pdf). The submissions must be named as follows: schoolname_IAD.pdf using the complete school name. **Submit the IAD report as instructed on the event website. For Michigan and Lincolnevents submit through fsaeonline.com.**

*In the event that the FSAE Technical Committee requests additional information or calculations, teams have **one weekfrom the date of the request** to submit the requested information or ask for a deadline extension.

University Name: Czech Technical University in Prague
Team Contact: Bc. František Pech
Faculty Advisor: Ing. Vít Hlinovský CSc.

Car Number(s) & Event(s): ________________
E-mail Address: pechfran@fel.cvut.cz
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Material(s) Used	CF Hexcell 43200 Twill 2x2 3K 200g/m2; Divinycell H60
Description of form/shape	Elliptical cone
IA to Anti-Intrusion Plate mounting method	Mounted with four M8 made 8.8 bolts
Anti-Intrusion Plate to Front Bulkhead mounting method	Mounted with four M8 made 8.8 bolts
Peak deceleration (<= 40 g's)	30.5 g
Average deceleration (<= 20 g's)	14.7 g

Confirm that the attenuator contains the minimum volume 200mm wide x 100mm high x 200mm long YES

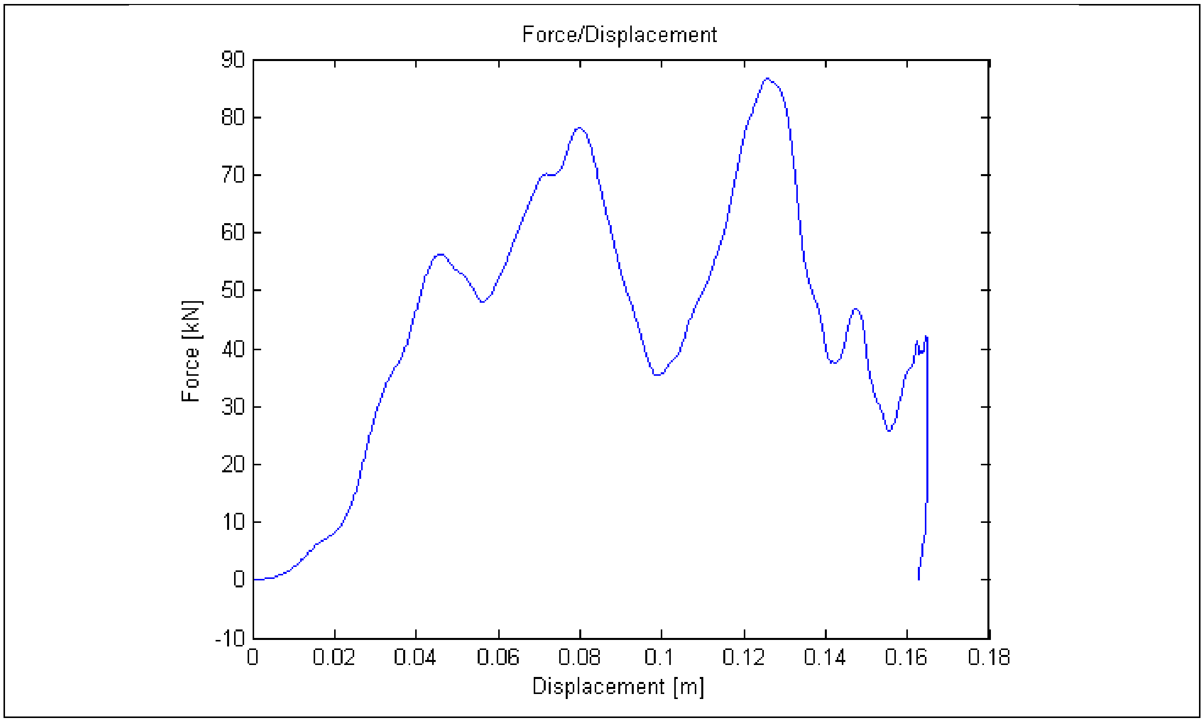

Figure 1: Force-Displacement Curve (dynamic tests must show displacement during collision and after the point v=0 and until force becomes = 0)

ATTACH PROOF OF EQUIVALENCY

TECHNICAL COMMITTEE DECISION/COMMENTS

____

Approved by____ Date_____________

NOTE: THIS FORM AND THE APPROVED COPY OF THE SUBMISSION MUST BE PRESENTED

AT TECHNICAL INSPECTION AT EVERY FORMULA SAE EVENT ENTERED

University Name: Czech Technical University in Prague Car Number(s) & Event(s): ____________________

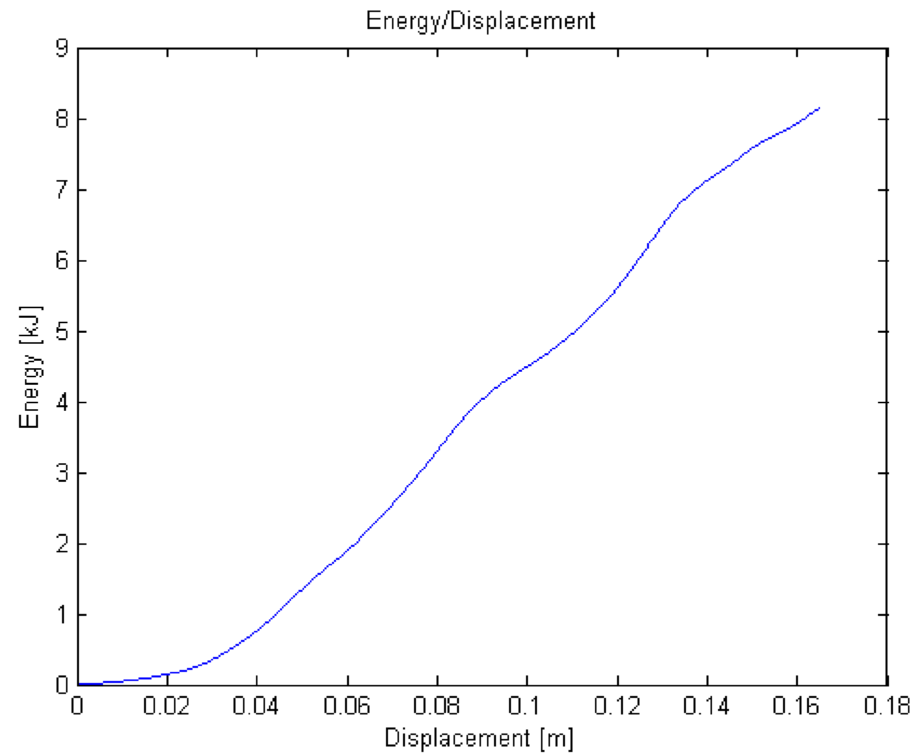

Figure 2: Energy-Displacement Curve (dynamic tests must show displacement during collision and after v=0)

Figure 3: Attenuator as Constructed

Figure 4: Attenuator after Impact

Energy Absorbed (J): Must be >= 7350 J	8144 J	Vehicle includes front wing in front of front bulkhead?	Yes
IA Max. Crushed Displacement (mm):	165	Wing structure included in test?	No
IA Post Crush Displacement - demonstrating any return (mm):	163	Test Type:(e.g. barrier test, drop test, quasi-static crush)	Drop test
Anti-Intrusion Plate Deformation (mm)	<2 mm	Test Site:(must be from approved test site list on website for dynamic tests)	CTU in Prague Department of Aerospace Engineering

University Name: Czech Technical University in Prague Car Number(s) & Event(s): ________________

T3.22.2, Note 2

The deceleration in vertical axis was measured. The velocity and displacement were iteratively calculated, using the assumption of a uniformly accelerated motion.

Velocity

$$v_{i+1} = v_i - aT,$$

where v...velocity [m.s^{-1}]
a...measured deceleration [m.s^{-2}]
T...sampling period [s]

The initial velocity in the moment of impact $v_0$was calculated from the law of conservation of mechanical energy (friction and air resistance are negligible):

$$\frac{1}{2}mv_0^2 = mgh$$

$$v_0 = \sqrt{2gh},$$

where g...gravitational constant [m.s^{-2}]
h...drop height [m]

Displacement

$$d_{i+1} = d_i + v_iT - \frac{1}{2}aT^2,$$

where d...displacement [m]

The displacement in the moment of impact was set $d_0 = 0$.

Energy

The absorbed energy E_a[J] was calculated as a difference of the mechanical energy at the moment and at the beginning of the impact

$$E_{ai} = (E_k + E_p)_0 - (E_k + E_p)_i = \frac{1}{2}mv_0^2 - \left(\frac{1}{2}mv_i^2 - mgd_i\right) = \frac{1}{2}m\left(v_0^2 - v_i^2\right) + mgd_i$$

Average deceleration

The average deceleration during the test $\bar{a}_{test}$ [m.s^{-2}]was calculated as a mean value of the measured deceleration between the moment of impact and the end of rebound (when $a = 0$). Because the test was conducted as a drop tower crash test, it was necessary to add the gravitational constant to the measured values of deceleration. Only then do the deceleration values correspond to those of a vehicle run horizontally into a barrier:

$$\bar{a}_{test} = \frac{1}{n_{end} - n_{start} + 1} \sum_{i=n_{start}}^{n_{end}} (a_i + g)$$

The mass m_{test} of the weight used for the test differed from $m_{req} = 300kg$ specified in the functional requirements. The average deceleration therefore had to be scaled in order to calculate the deceleration corresponding to m_{req}:

$$F_{test} = F_{req}$$

$$m\bar{a}_{test} = m_{req}\bar{a}_{req}$$

$$\bar{a}_{req} = \frac{m}{m_{req}}\bar{a}_{test}$$

Peak deceleration

The peak deceleration during the test $\hat{a}_{test}$ [m.s^{-2}] was determined as the highest deceleration between the moment of impact and the end of rebound (when $a = 0$). The CFC 60 filter was used to filter the peaks in the raw data. For the same reason as in the calculation of the average deceleration, the gravitational constant was added to that value and the result then scaled:

$$\hat{a}_{test} = \max_{n_{start} \le i \le n_{end}} \{a_i + g\}$$

$$\hat{a}_{req} = \frac{m}{m_{req}} \hat{a}_{test}$$

T3.22.3, b)
Wing is attached by 8 aluminium M5 bolts trough endplate to frame.

Fasteners shear calculation

Material used:
Aluminium EN AW 6060 T.6
$R_{p0,2} = 160\ MPa$ Yield strength
$R_m = 215\ MPa$ Ultimate strength

Shear stress:

$$S = \frac{4F}{\pi * d^2}\ [MPa]$$

Shear force on 1 bolt

$$F_{bolt} = \frac{S * \pi * d^2}{4}\ [N]$$

$$F_{bolt} = \frac{R_m * \pi * d^2}{4} = \frac{215 * \pi * 4{,}02^2}{4} = 2{,}73\ kN$$

Total force needed for wing attachment failure:

$$F_{wing} = 8 * F_{bolt} = 21{,}84\ kN$$

Total force during impact:

$$F_{IA} = m * g * a_{peak} = 300 * 9{,}81 * 30{,}5 = 89{,}7\ kN$$

$$F_{total} = F_{wing} + F_{IA} = 21{,}84 + 89{,}7 = 114{,}54\ kN$$

$$F_{limit} = m * g * a_{max} = 300 * 9{,}81 * 40 = 117{,}72\ kN$$

$$F_{total} < F_{limit}$$

Insert Required Calculation T3.22.2 note 2 and T3.22.3

University Name: Czech Technical University in Prague Car Number(s) & Event(s): __________________

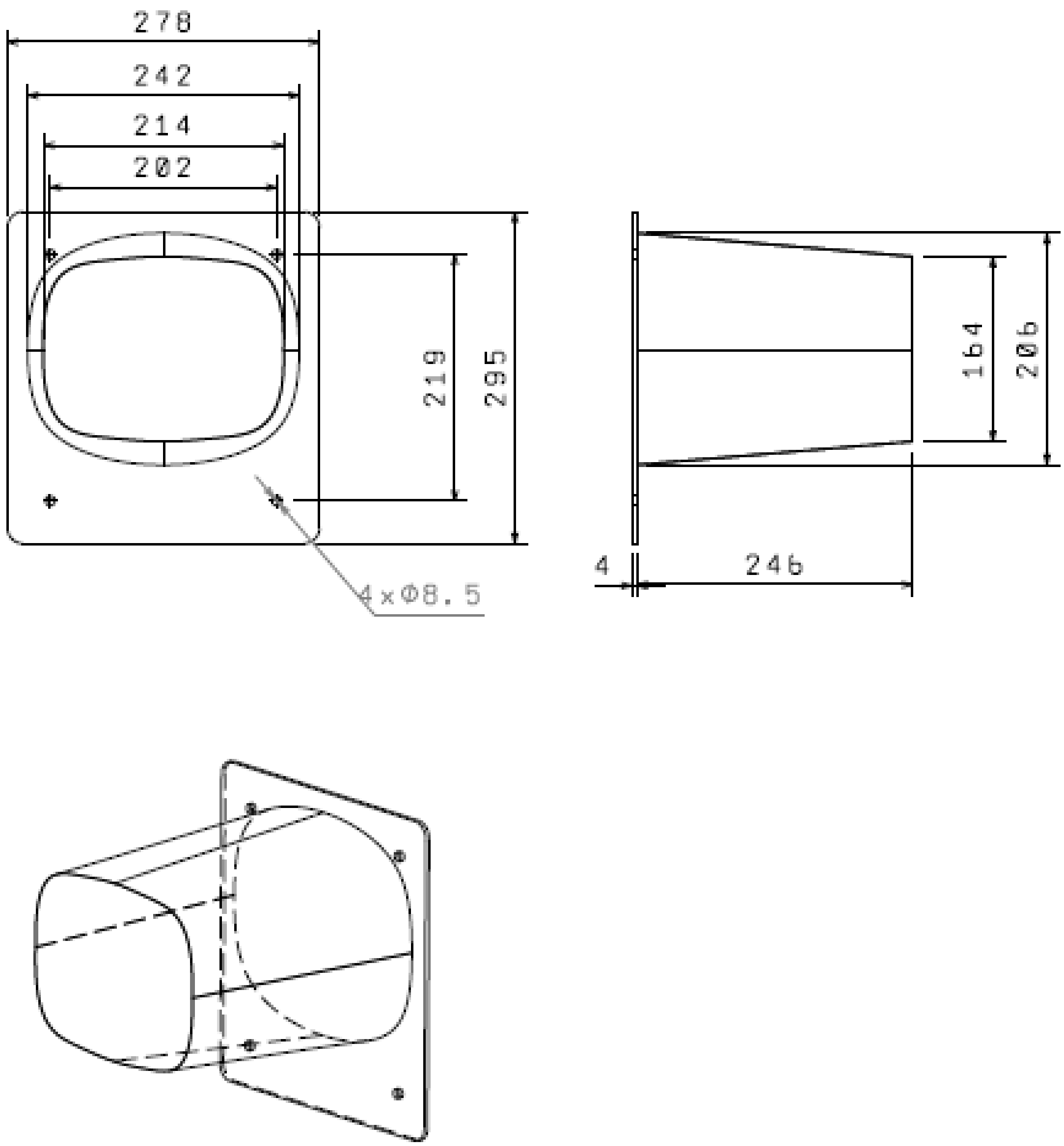

Figure 5 : Design Drawings

Length (fore/aft direction):250mm (>=200mm)
Width (lateral direction): 242mm (>=200mm)
Height (vertical direction):206mm (>=100mm)
Attenuator is at least 200mm wide by 100mm high for at least 200mm: Yes
Attach additional information below this point and/or on additional sheets

Test schematic, photos of test, design report including reasons for selection and advantages/disadvantages, etc. Additional information shall be kept concise and relevant.

