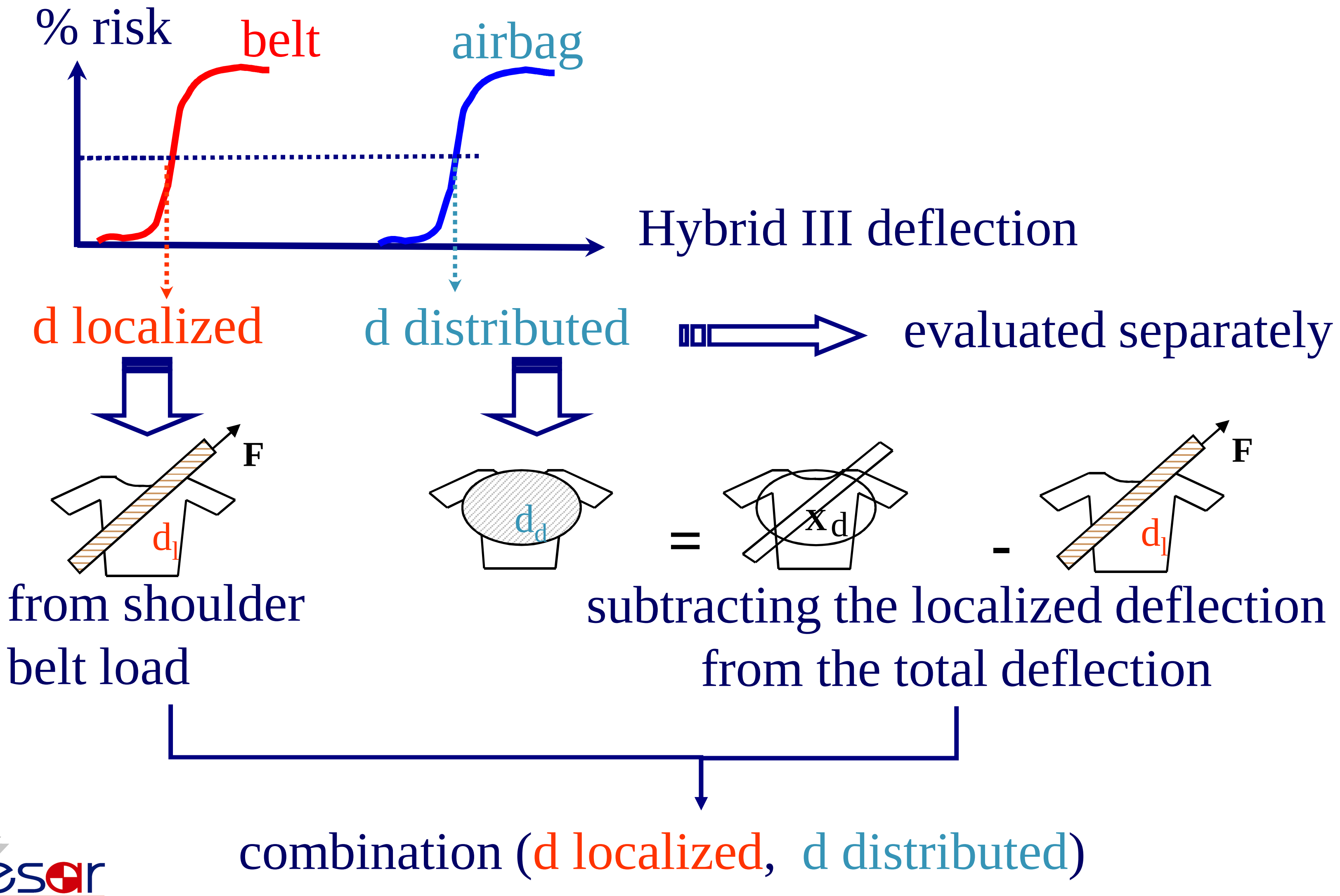
Deq
principles, IRCs and thresholds

Informal Group on Frontal Impact

GRSP

November 23th, 2012

1. General principle



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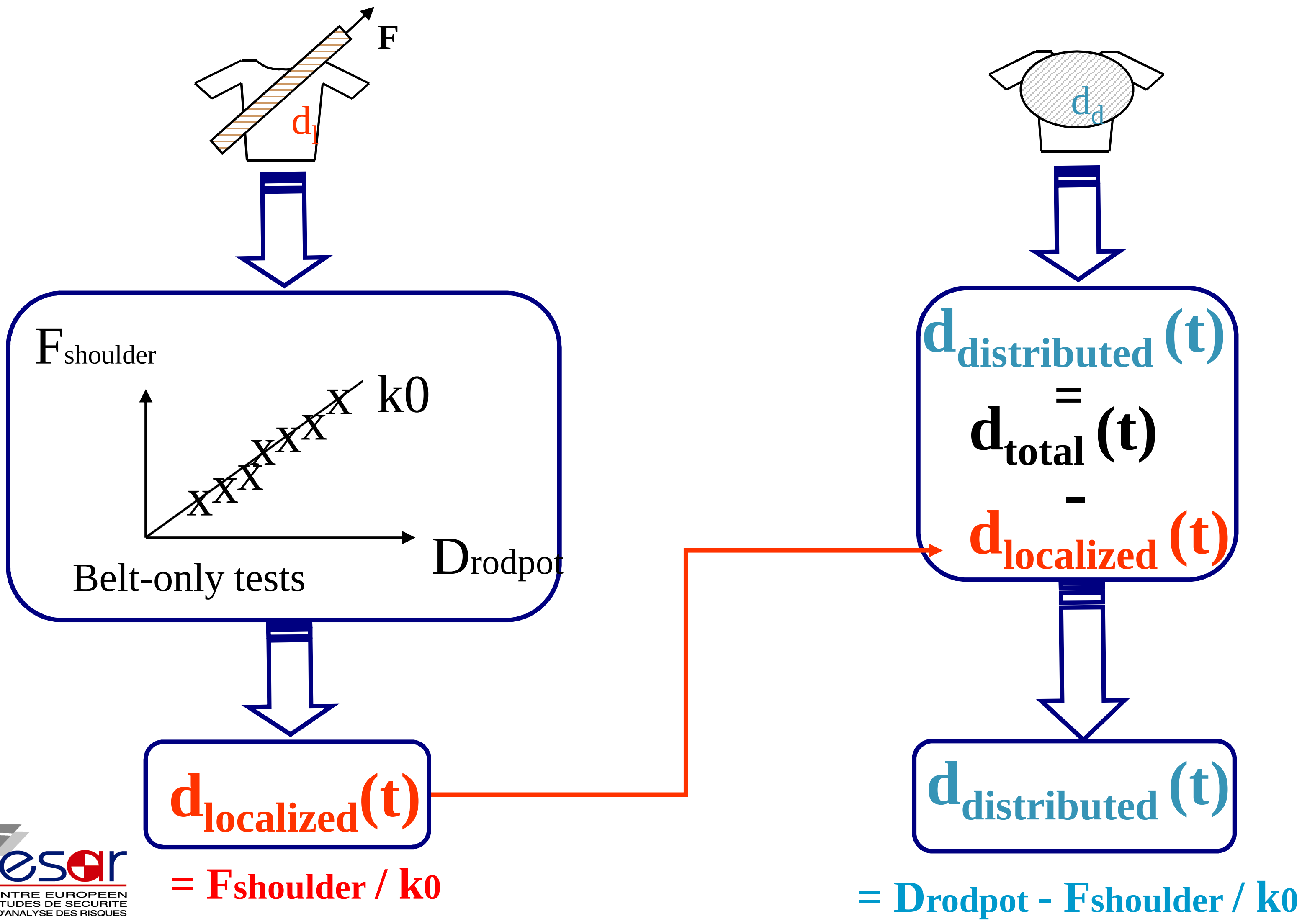

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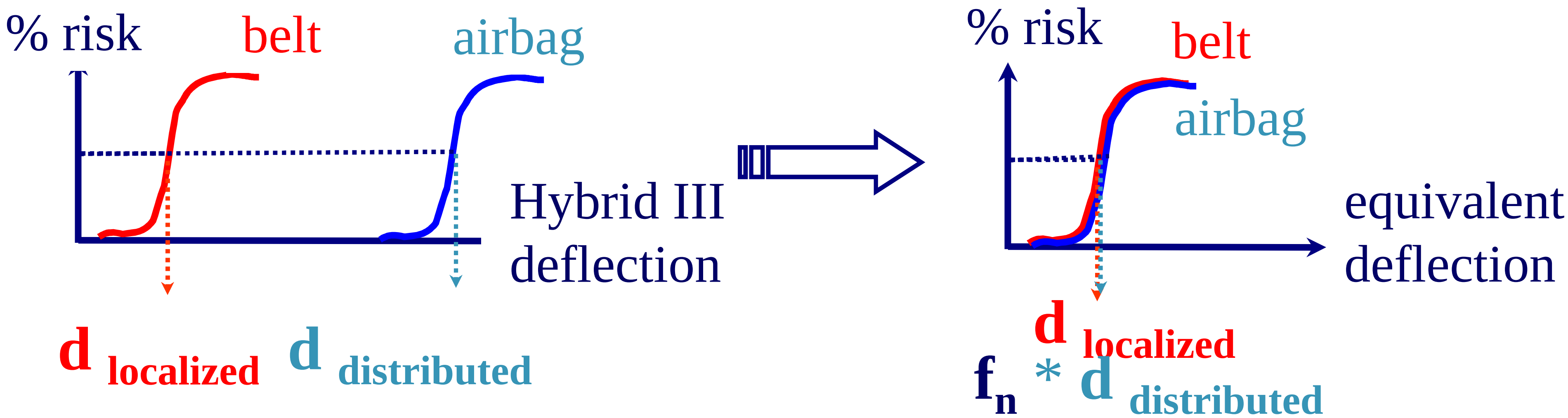

$d_{localized}$

$f_n * d_{distributed}$

$$d_{equivalent} = d_{localized} + f_n * d_{distributed}$$

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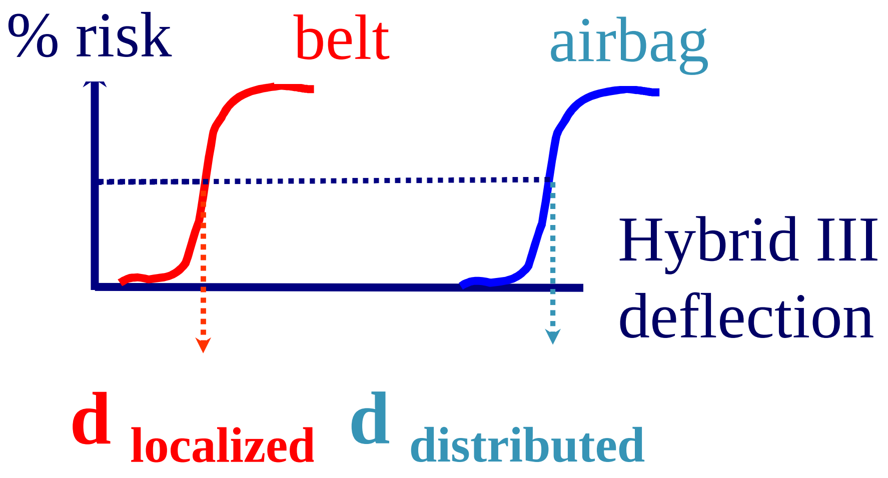
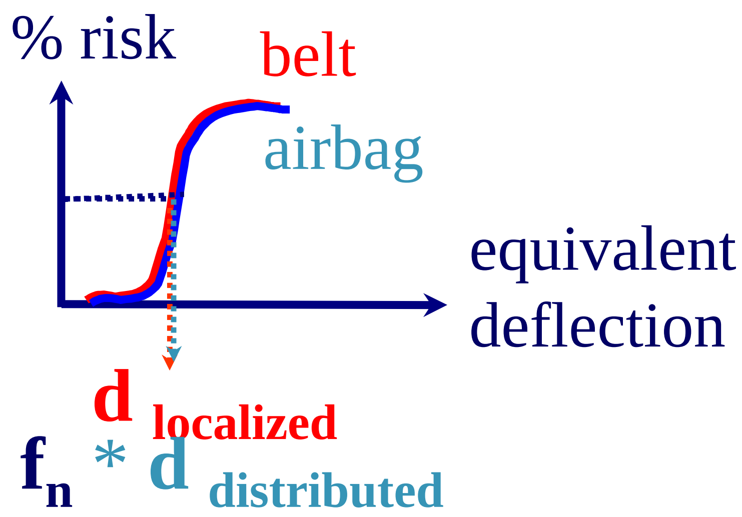


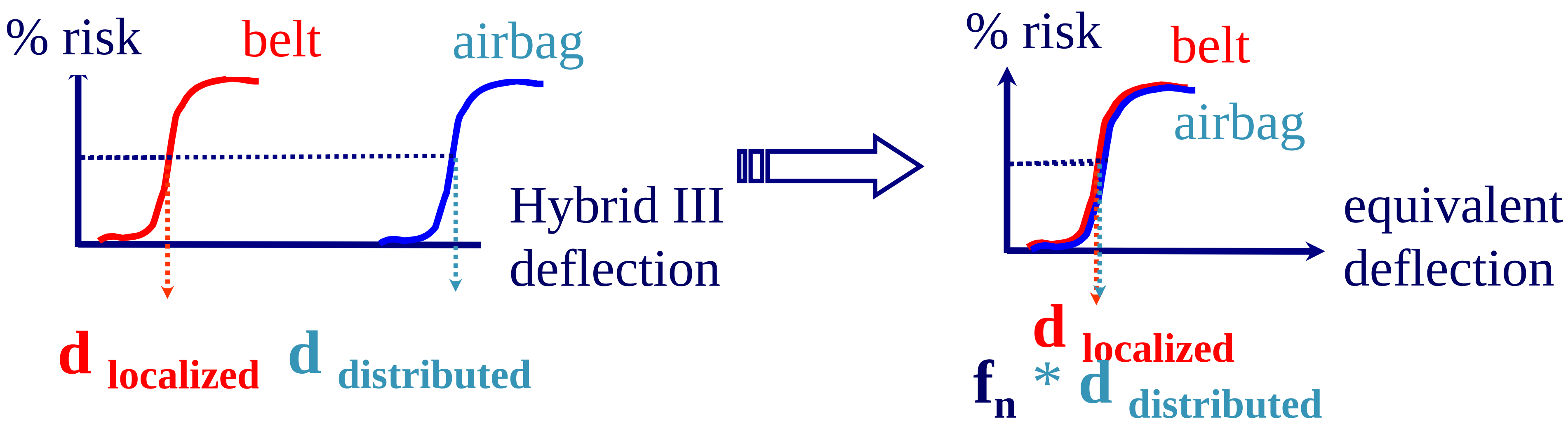


$d_{localized}$

$f_n * d_{distributed}$

$$d_{equivalent} = Fshoulder / k0 + f_n * (Drodpot - Fshoulder / k0)$$

1. General principle



$d_{localized}$

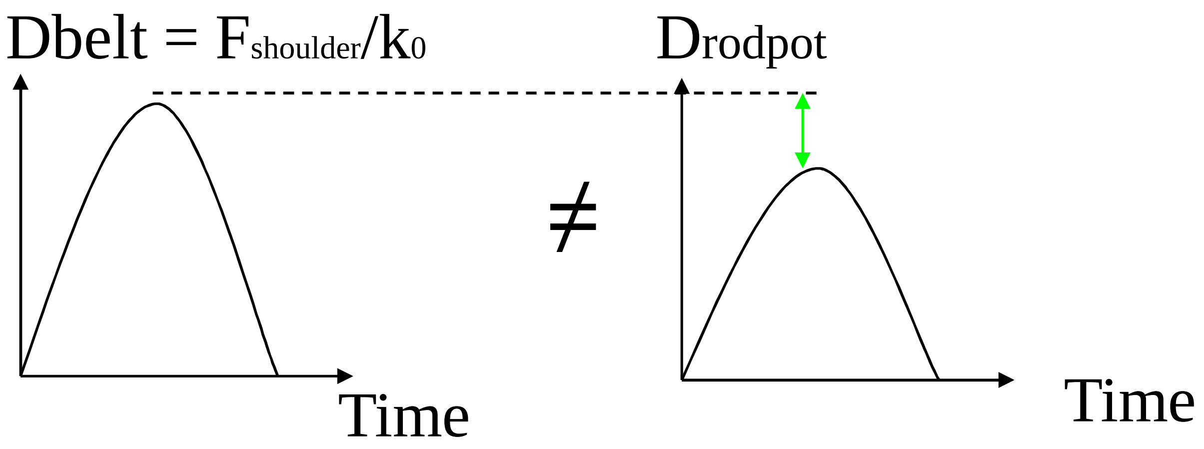
$f_n * d_{distributed}$

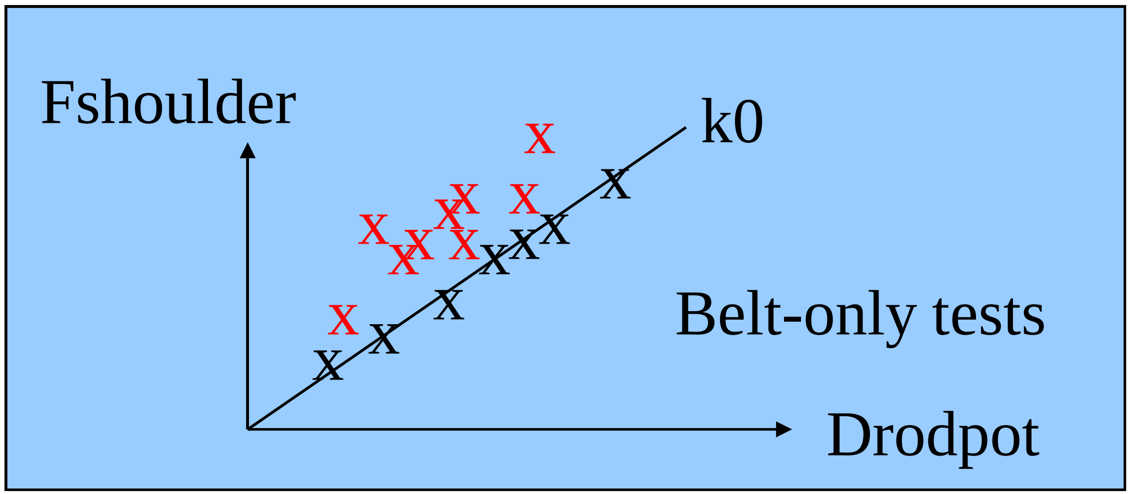
$$D_{equivalent} = \alpha * Fshoulder + \beta * Drodpot$$

2. Adjustments

- Rodpot does not measure the maximum deflection
- Deq accounts for chest viscous component

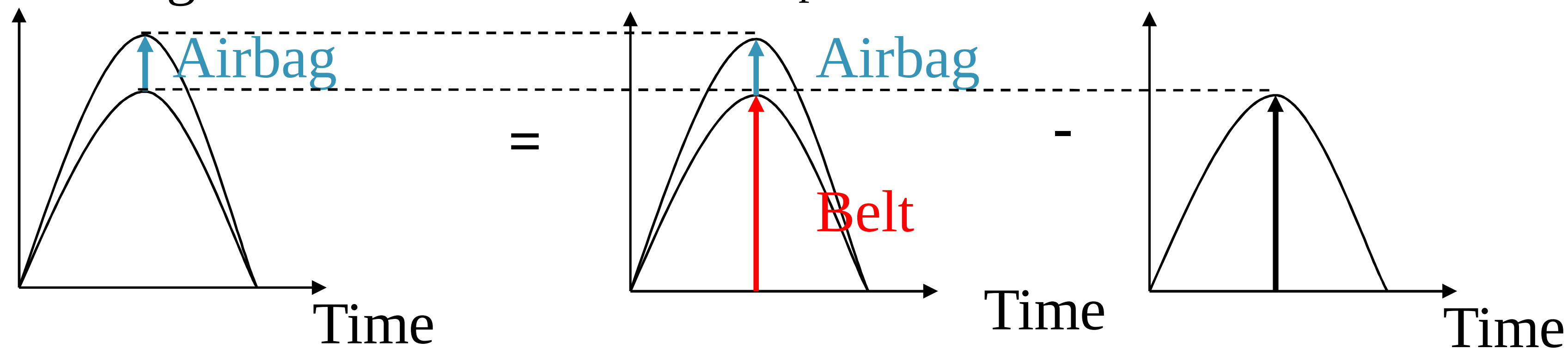
2. Adjustments
Belt contribution

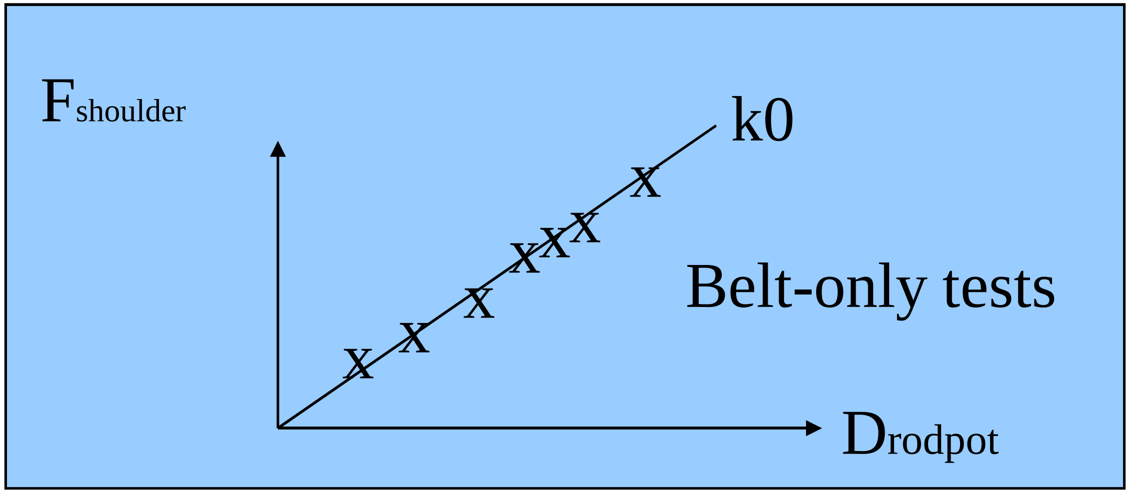




2. Adjustments
AB contribution

$D_{airbag} = D - F_{shoulder}/k_0$ $D = D_{rodpot}$ $F_{shoulder}/k_0$





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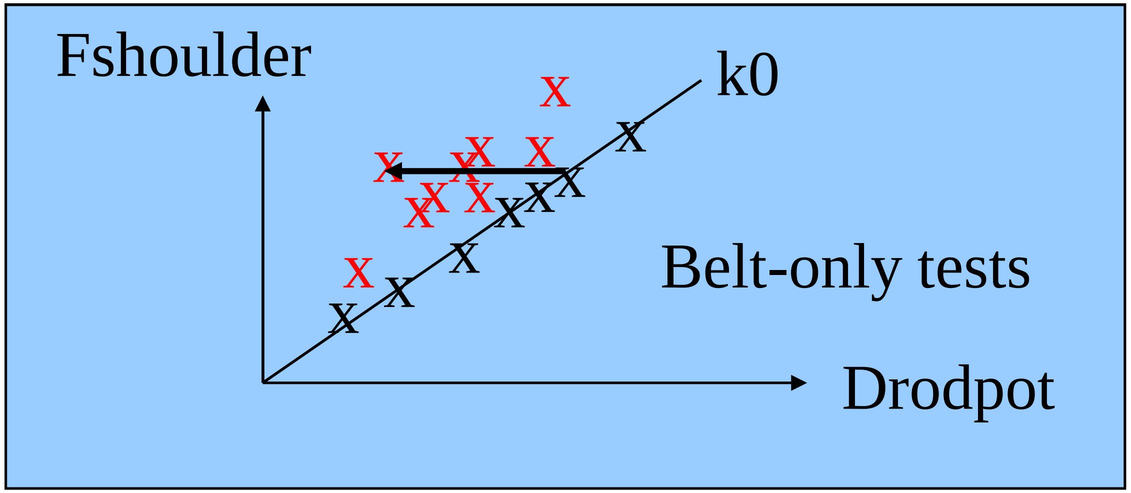

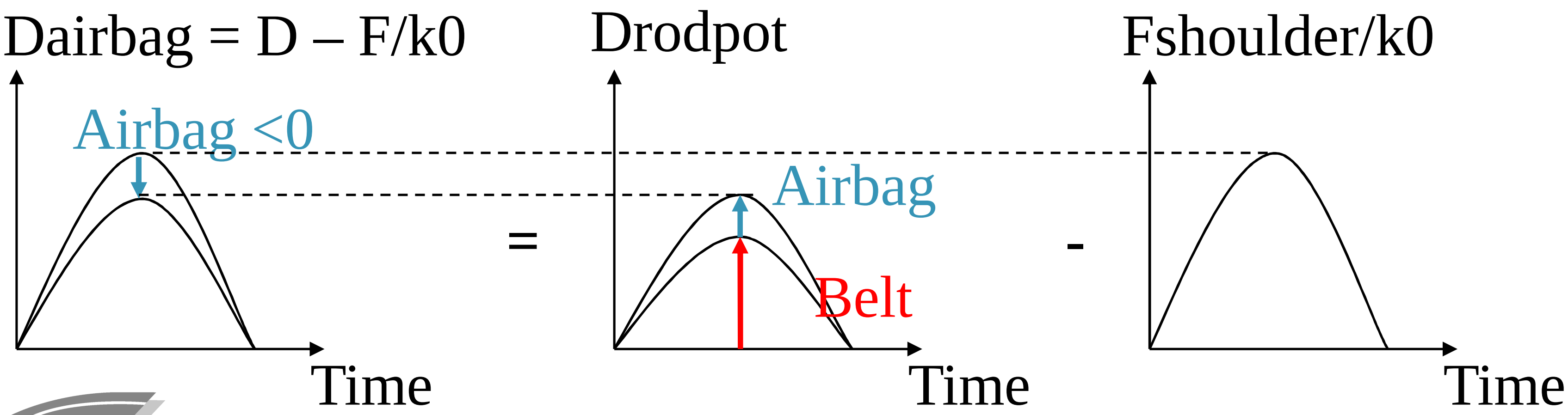

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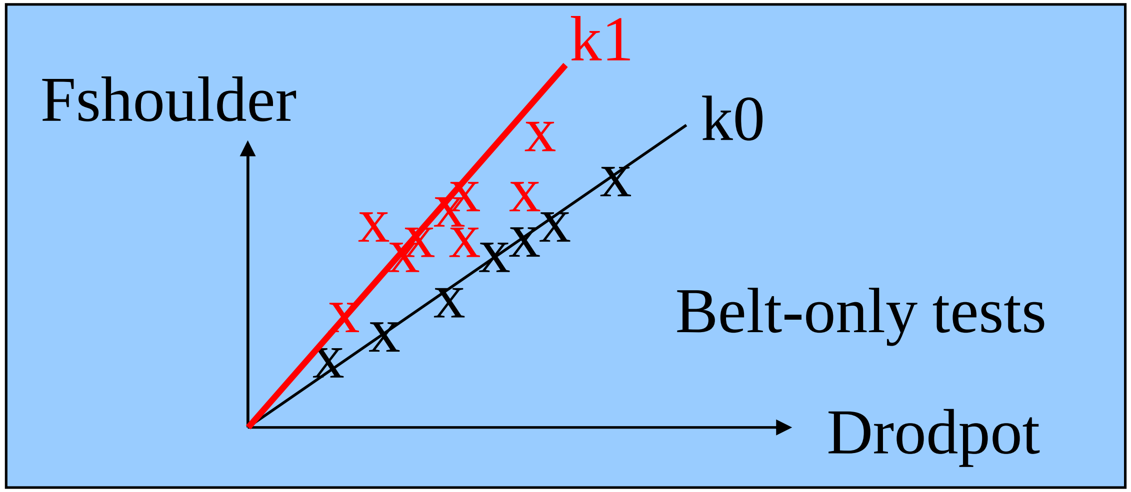
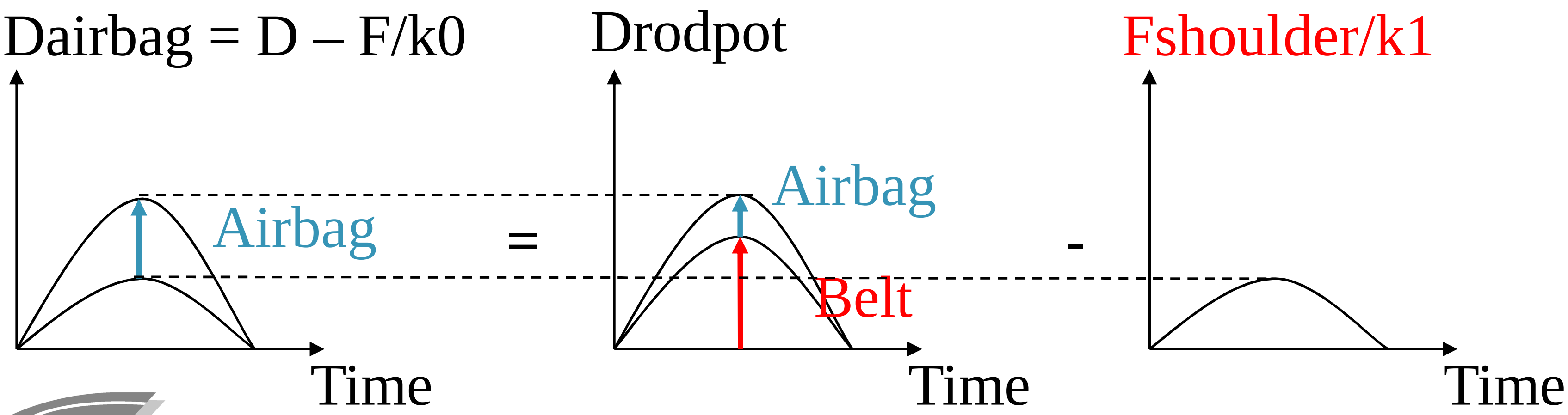
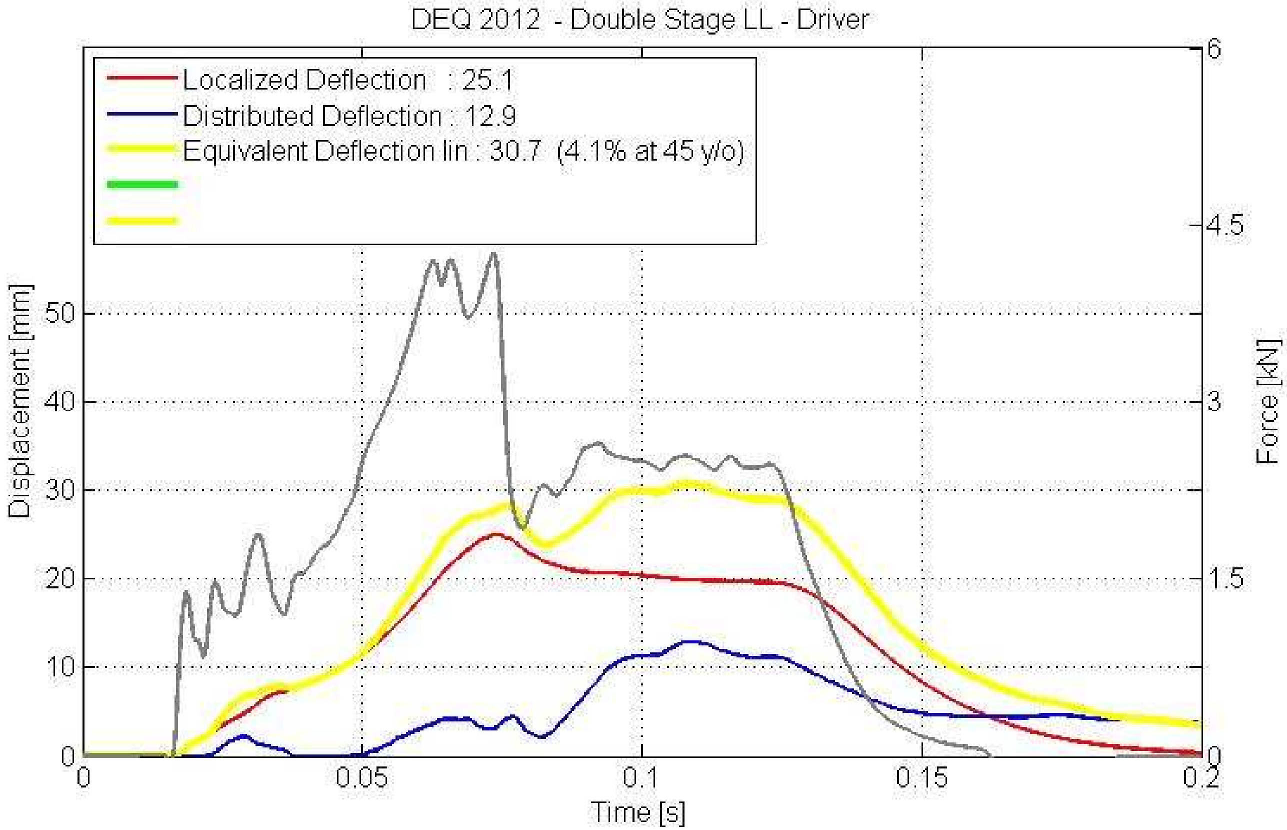




2. Adjustments
Viscous component



- Exact DeqLin: 30.7 (4.1% risk @45y/o)
- Simplified DeqLin: 35.2 (7% risk @45y/o)

DEQ LIN

- DEQ LIN = max (d_{belt} (t) + Fn * d_{airbag} (t))

- Belt contribution
  - k1 = 136 - 0.0018*USBF (USFB= Upper shoulder belt Force in N)
  - c1 = 0.0185*k1 - 0.2357 (c1 = effect of the viscous component)

- Airbag contribution
  - k1 = 238 - 0.0023*USBF (USFB= Upper shoulder belt Force in N)
  - c1 = 0.0185*k1 - 0.2357

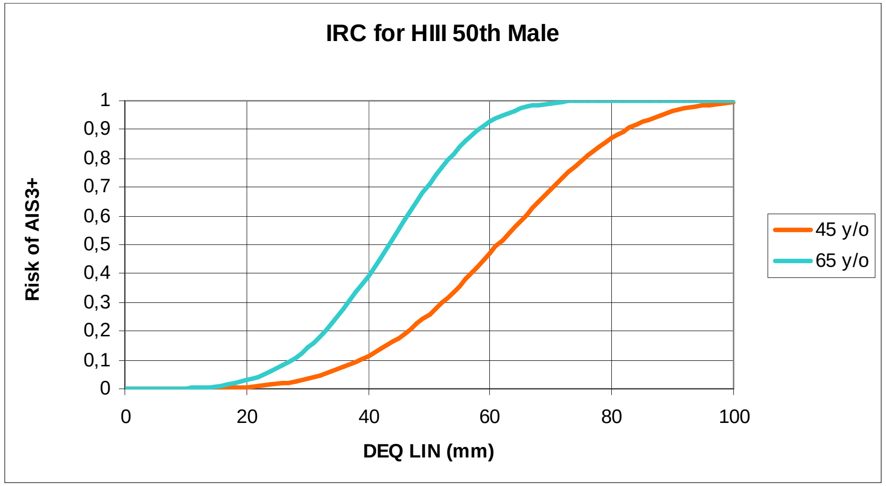
- Fn = 0.84

Injury Risk Curves

- HIII 50th Male

$$Injury\,risk(50th) = 1 - \exp\left(-\exp\left(\frac{\ln(deq) - 4.99 + 0.0174 * age}{0.246}\right)\right)$$

DEQ values		
HIII 50th	45 y/o	65 y/o
5%	33	23
25%	50	35
50%	62	44

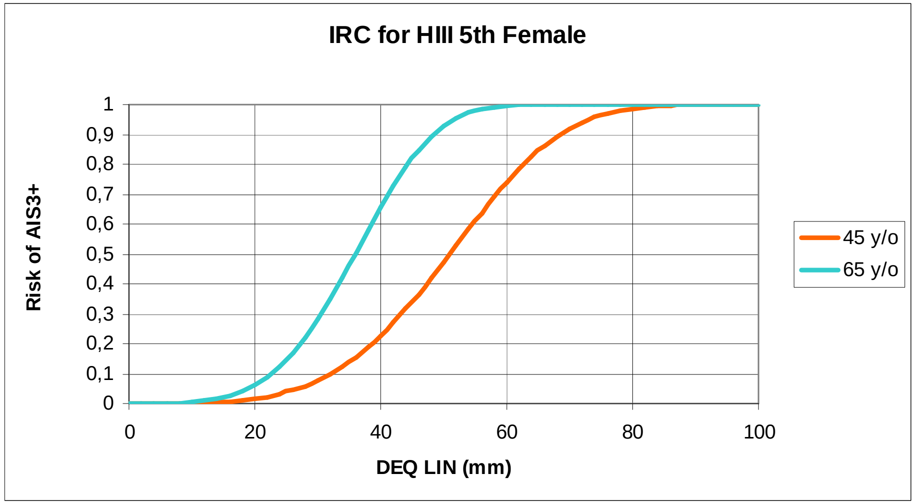


Injury Risk Curve

HIII 5th Female

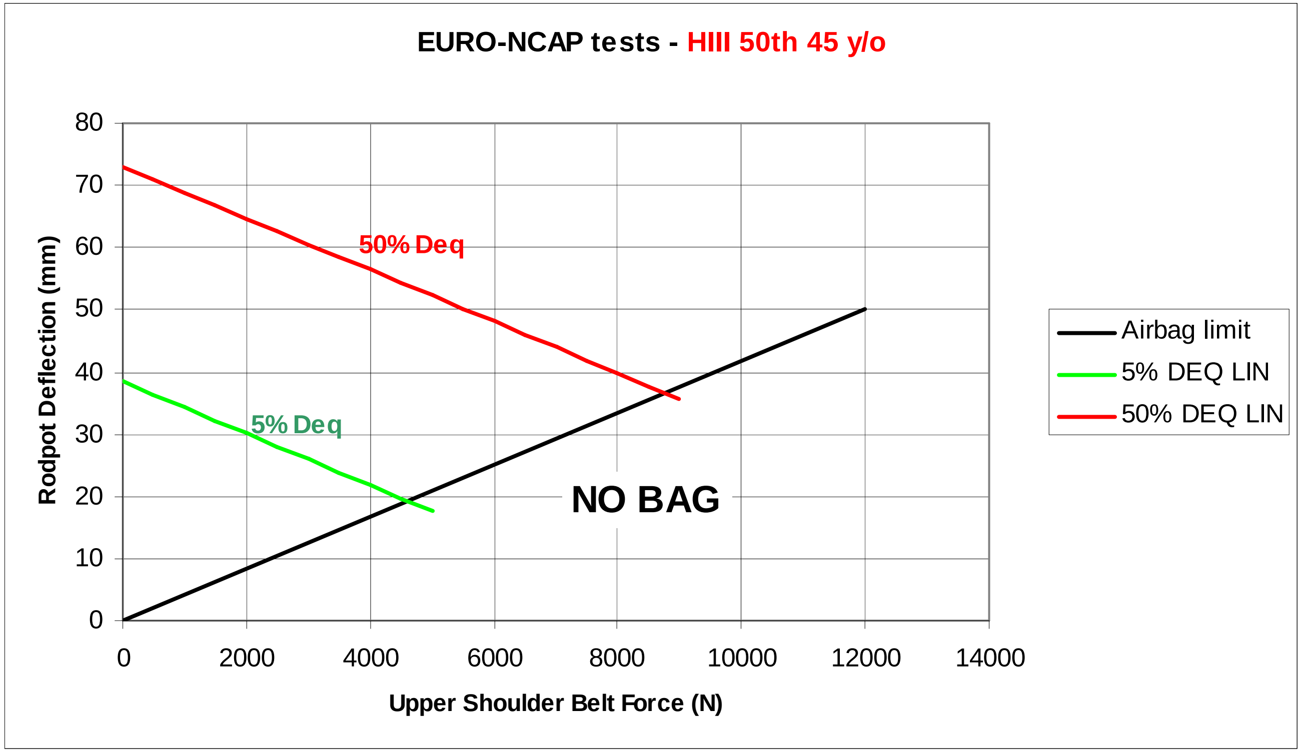
$$Injury\,risk(50th) = 1 - \exp\left(-\exp\left(\frac{\ln(deq/0.83) - 4.99 + 0.0174*age}{0.246}\right)\right)$$

DEQ values		
HIII 5th	45 y/o	65 y/o
5%	27	19
25%	41	29
50%	51	36



Test results

HIII 50th - 45 y/o



Deq LIN ⇔ 6.6*USBF(kN) + 0.84*(Rodpot(mm) - 3.7*USBF(kN))

Deq IRC has nothing to do with Rodpot IRC
Ex for belt-only : 5kN / 22mm Rodpot ⇔ Deq=36 (4% AIS3+)

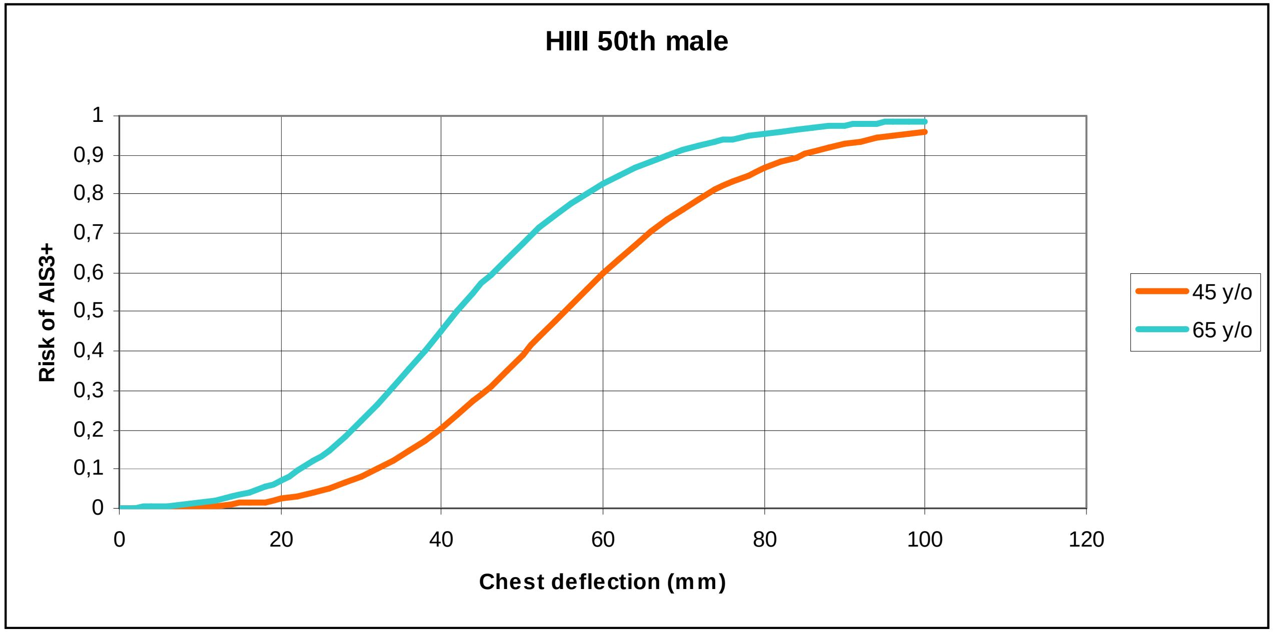
Deq = not a physical measurement

Laituri - Injury Risk Curve

HIII 50th Male – NHTSA (Laituri 2005)

$$Injury\ risk(50th) = \frac{1}{1+\exp^{12.597-0.05861*age-1.568*(ChestDefl)^{0.4612}}}$$

HIII 50th	45 y/o	65 y/o
5%	26 mm	17 mm
25%	43 mm	32 mm
50%	55 mm	42 mm



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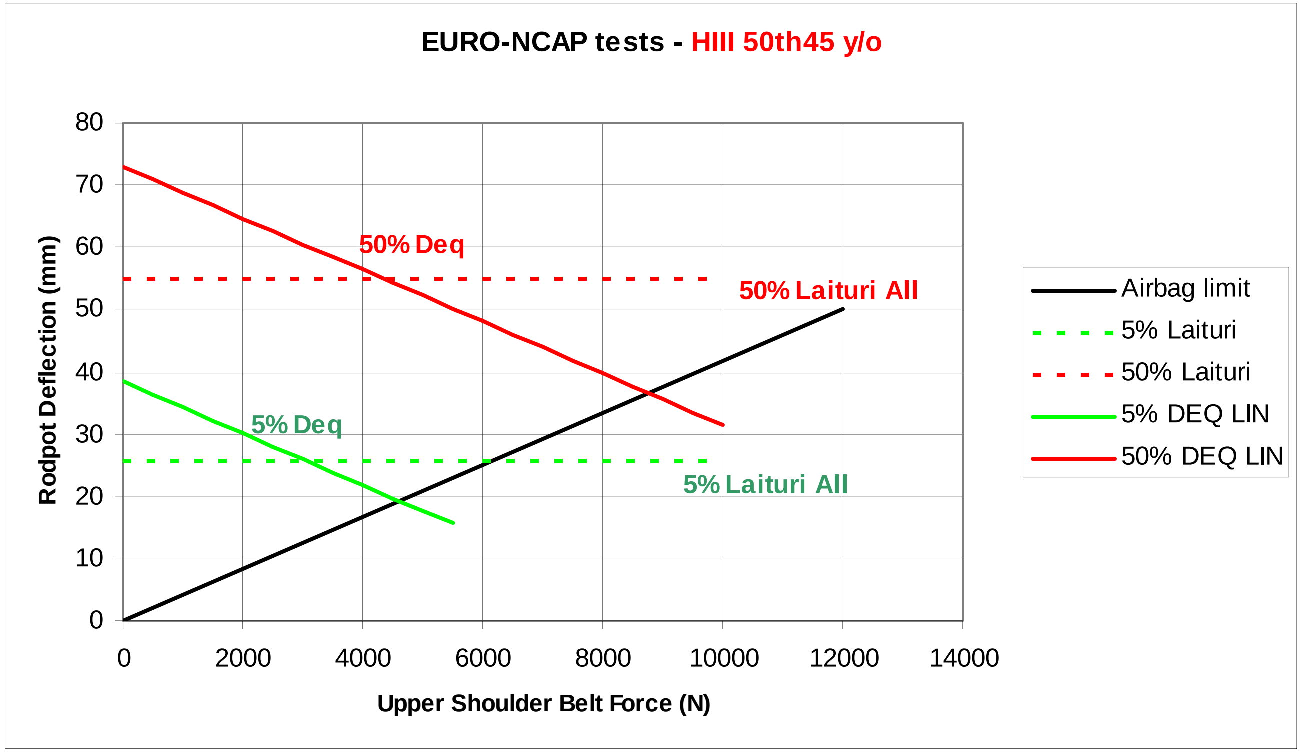


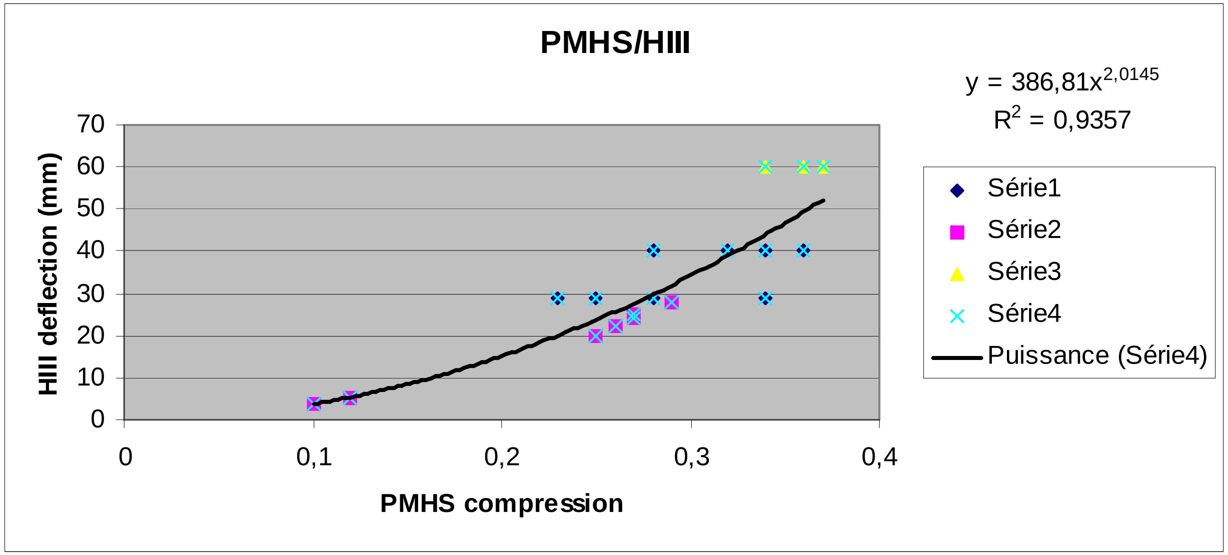
Deq LIN ⇔ 6.6*USBF(kN) + 0.84*(Rodpot(mm) - 3.7*USBF(kN))

Injury Risk Curve

- Laituri IRC
  - Data from Sled (Belt (19), Combined (29))
  - Data from Table top tests (Belt (35), distributed (16), 2 diag (14), blunt (17))
  - Data from Blunt (44)
  - Data from OOP tests(12)

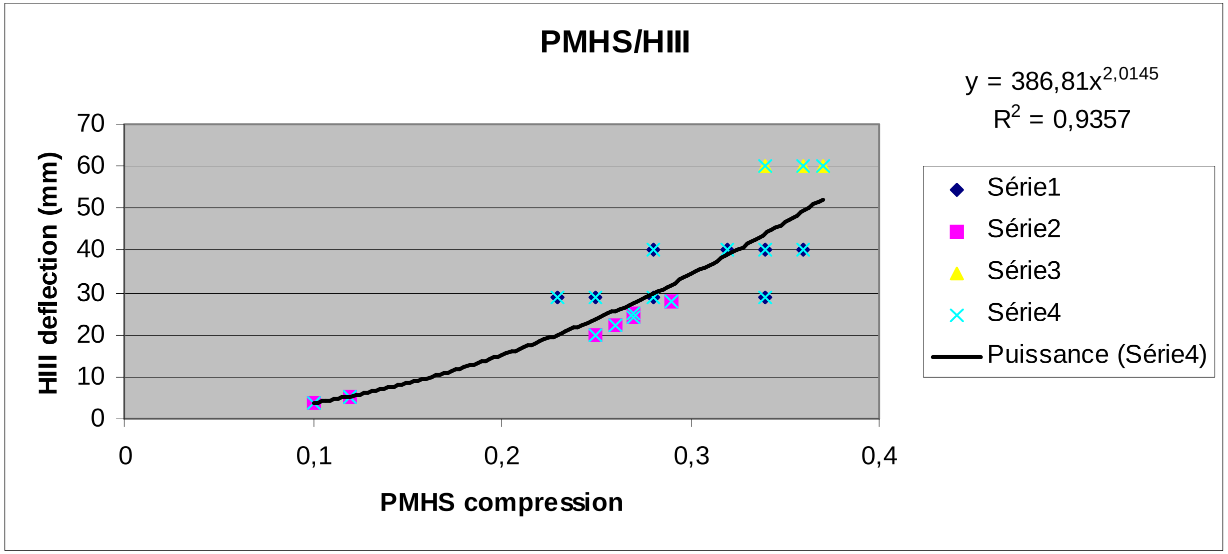
  - PMHS IRC

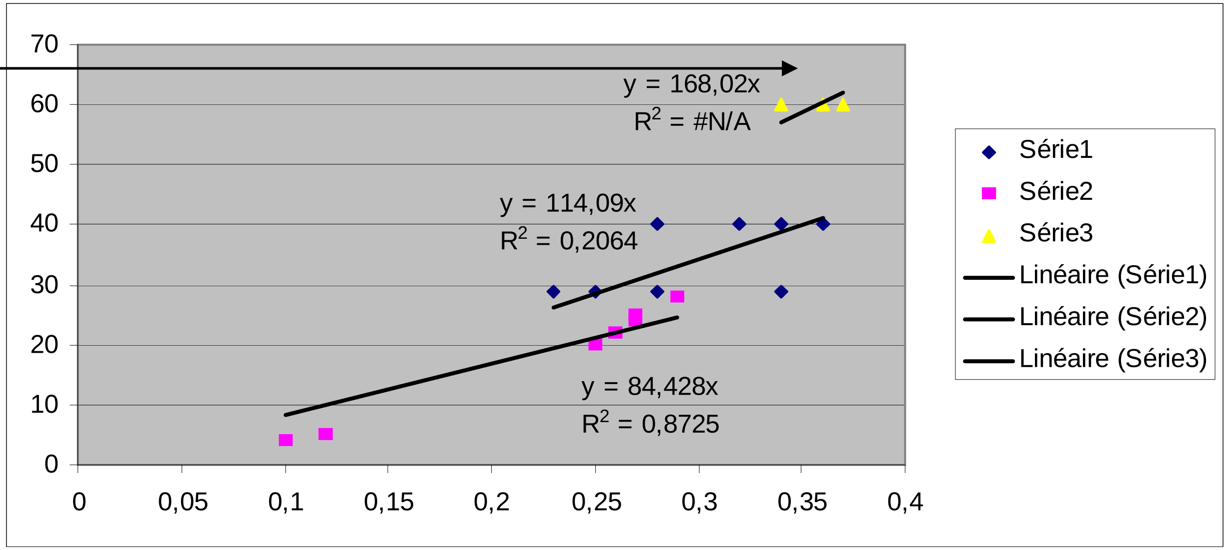
  - Transfert to HIII



Injury Risk Curve

- Laituri IRC
  - All configurations considered as a whole by Laituri
  - Should split different configurations
    - Blunt significantly different from Belt





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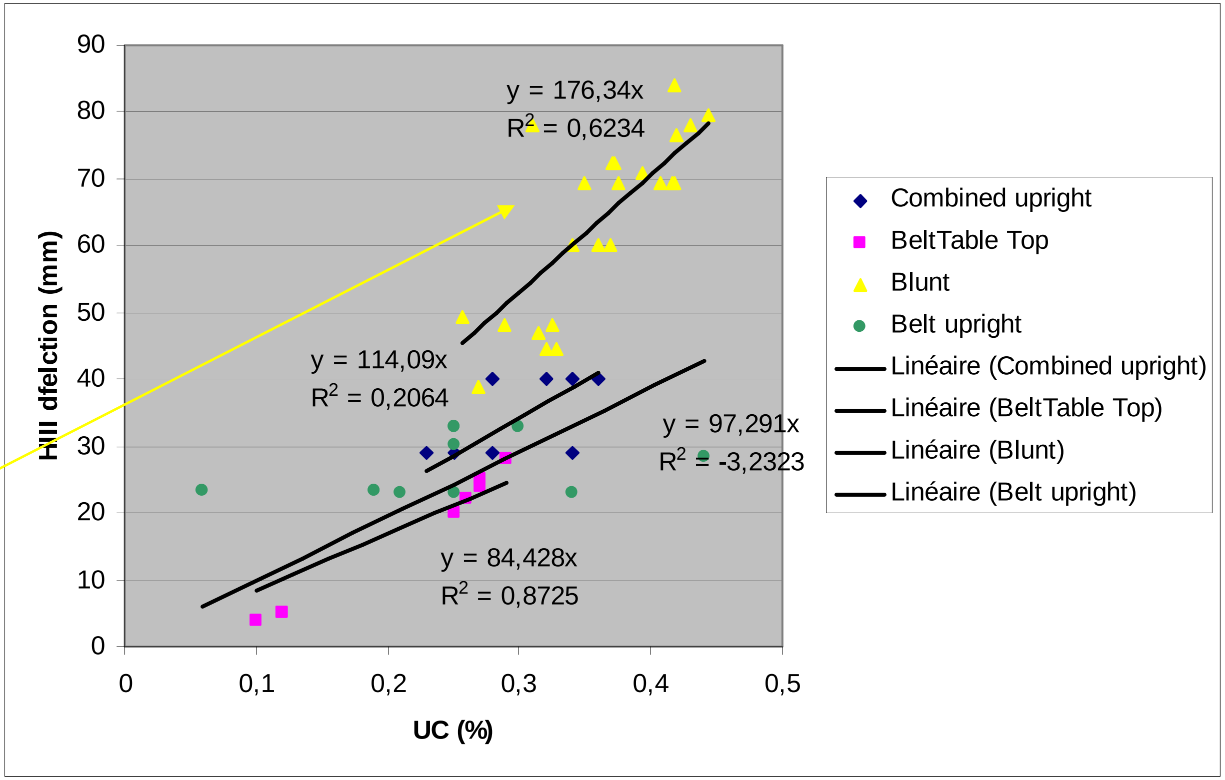
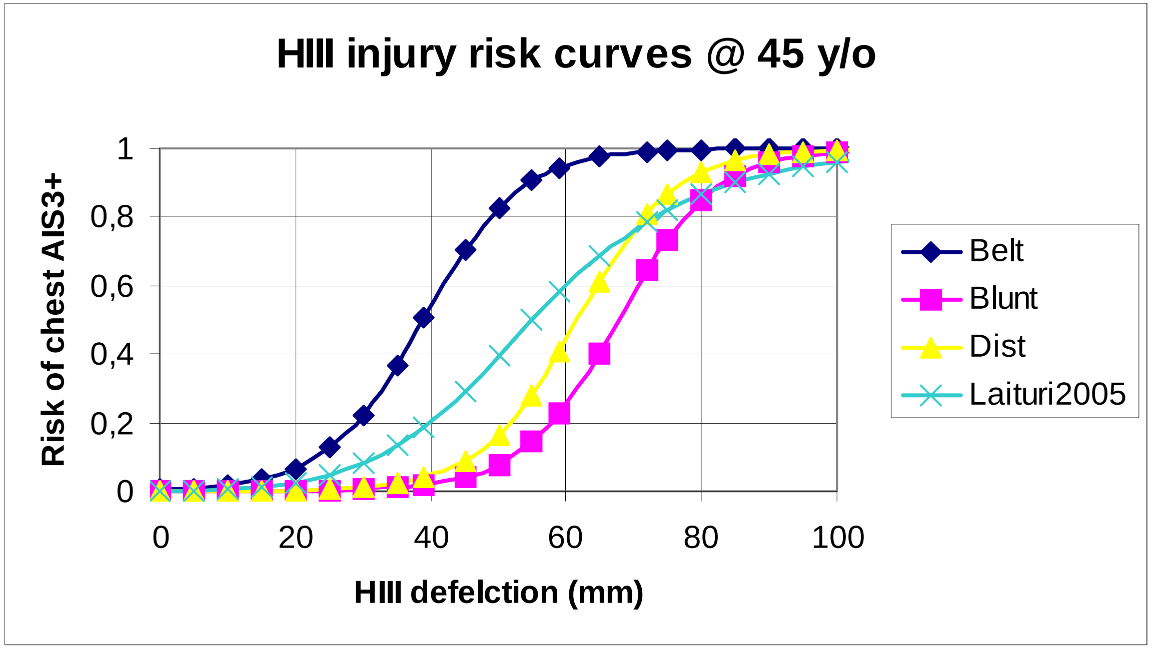


With additional Blunt tests and Belt-only sled tests

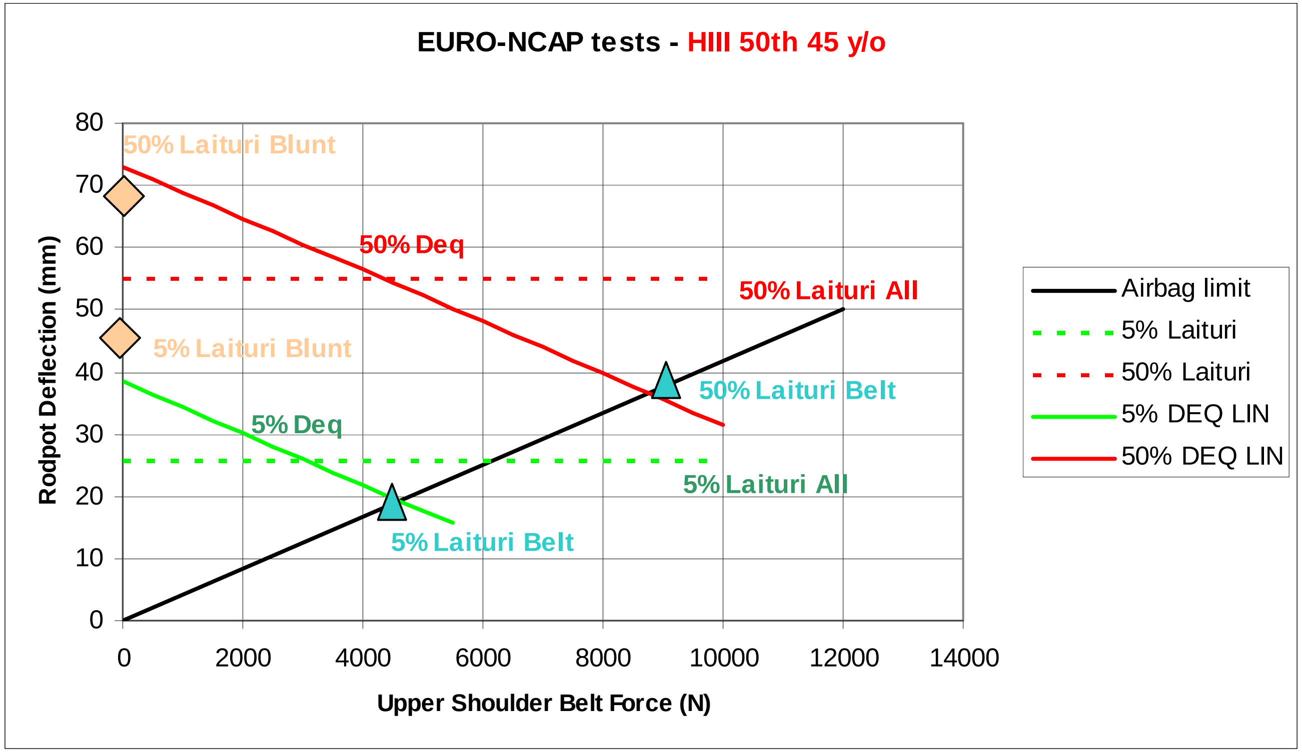
Injury Risk Curve

- Laituri IRC



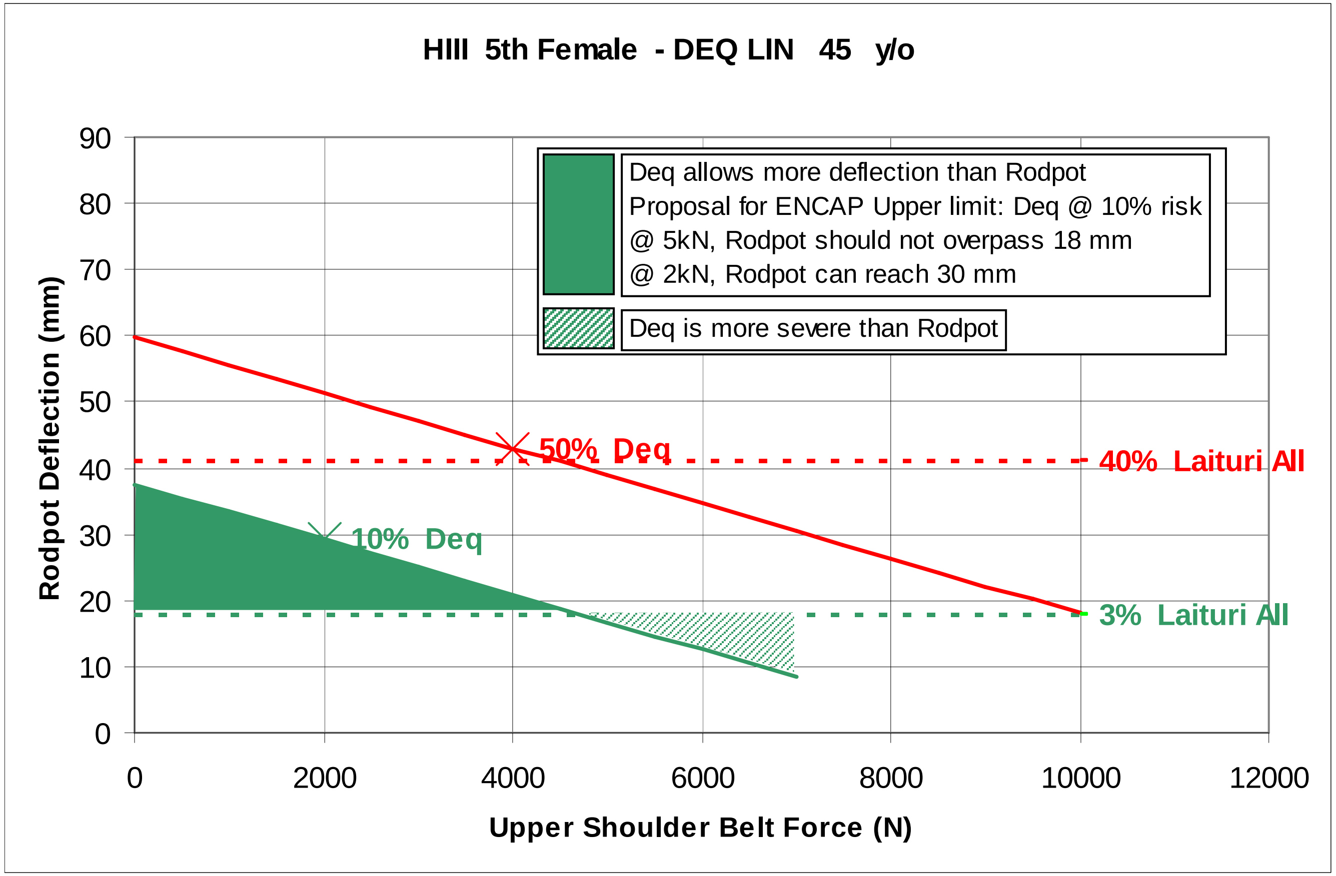
Thresholds

HIII 50th - 45 y/o



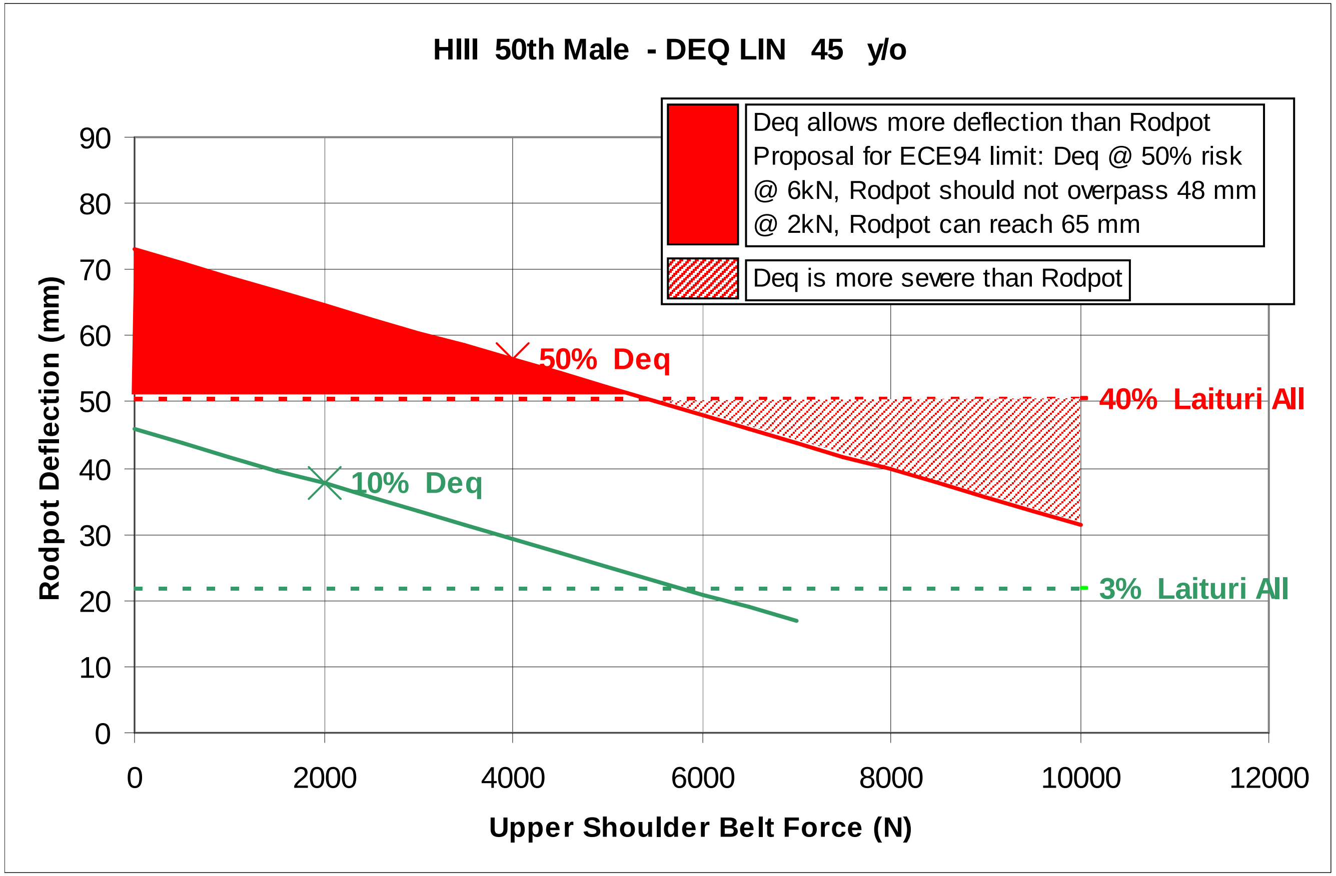
Deq LIN ⇔ 6.6*USBF + 0.84*(Rodpot-3.7*USBF)

Thresholds



HIII 5th - 45 y/o for **ENCAP** UPPER limit

Thresholds



HIII 50th - 45 y/o for **ECE94** limit

and **ENCAP** LOWER limit