



Injury Criteria Workshop

Workshop Introduction and Scope

Dr A. R. Payne

MIRA Ltd



Injury Criteria Workshop

- **What are 'Injury Criteria'?**
- **Where did 'Injury Criteria' come from?**
- **How are 'Injury Criteria' currently used?**
- **How 'injury Criteria' be applied to Rail Interiors?**
- **Injury Criteria Options for Rail Interiors**

What are 'Injury Criteria'?

'An injury criteria is a mathematical relationship, based on empirical observation, which formally describes a relationship between some measurable physical parameter interacting with a test subject and the occurrence of injury that directly results from that interaction.'

S. W. Rouhana 1993

An engineering parameter (acceleration, force, displacement) which mimics an injury causation mechanism, that can be used to assess the potential injury level produced from that mechanism.

Where did 'Injury Criteria' come from?

Mainly the Automotive Industry

- Based on the body part impact areas and mechanisms for seated car occupants with restraint systems

Frontal – Head, Chest, Femurs
Neck, Lower Legs
Side - Head, Chest, Abdomen, Pelvis

- Based on the instrumentation with crash test dummies

Frontal - HIII (50%, 95%, 5%, 10yr, 6yr, 3yr, 18mth), THOR
Side - USSID, EuroSID, WorldSID (50%) SIDIIIs (5%)
Accelerometers / Potentiometers / Load Cells

How are 'Injury Criteria' currently used?

- **Automotive Industry**
 - Tolerance levels for injury criteria are used to 'Benchmark' vehicle injury criteria.
 - Set minimum levels - Legislation (FMVSS208)
 - Compare vehicles - Consumer Tests (EuroNCAP)
 - They are not to look at actual injuries or injury levels but to improve vehicle crashworthiness performance.
 - As Crashworthiness performance improves tolerance levels lower
 - Concerned with fatality and serious disability NOT egress
- **Aerospace**
 - Adopted Automotive injury criteria but set tolerance limits to biomechanical levels



How 'Injury Criteria' has been applied to Rail Interiors?



UK Interior Crashworthiness Standard AV/ST9001

- Injury Criteria taken from Automotive Industry as HII crash test dummy is used as the assessment tool.

Head –	Resultant Acc / Head Injury Criteria (HIC)
Neck –	Resultant Bending Moment
Chest –	Chest deflection (method too crude)
Abdomen –	Intrusion (frangible abdomen not applicable)
Legs –	femur loads / sliding knee / tibia index

- Tolerance Levels based on unrestrained occupant (ECE R80 Coach Seat)

HIC –	500	(5% Life threatening injury)
Chest Deflection -	30mm	(rib fracture)
Abdominal Compression -	40mm	(abdominal injury)
Femur Load -	4Kn	(Femur fracture 6-9Kn – Knee/pelvis injury)
Knee Joint Shear –	12mm	(Cruciate ligament rupture)
Tibia Index –	0.75	(tibia fracture at 1)



Injury Criteria Options for Rail Interiors

- **Should Injury Criteria attempt to simulate actual injuries in rail vehicles?**
 - Are we trying to assess actual injuries / injury levels or benchmark to improve interior occupant protection?
- **Should Injury Criteria tolerance levels represent:-**
 - Probability of fatal / life threatening / serious injury levels?
 - Probability of injury levels likely to effect egress?
 - Probability of injury levels covering the whole population (6 mths – 80 yrs)?

What Assessment techniques should we use?

- Crash Test Dummies (HIII / THOR / ?)
- Component Level Tests (free flight head forms / ?)
- Computer Models (Dummy models / Human Models)