

# TABLE OF CONTENTS

## SECTION 1: THE HUMAN THORAX-SHOULDER COMPLEX - ANATOMY AND FUNDAMENTALS OF BLUNT IMPACT TRAUMA

<b>The Anatomy of the Human Chest (P-67)</b> .....	<b>1</b>
D. Huelke	
<b>An Introduction to the Understanding of Blunt Chest Trauma (P-67)</b> .....	<b>11</b>
G. Mulligan, G. Pizey, D. Lane, L. Andersson, C. English, C. Kohut	

## SECTION 2: BIOMECHANICS, IMPACT RESPONSE AND TRAUMA ASSESSED WITH VOLUTEERS, CADAVERS, ANIMAL AND MECHANICAL SURROGATES IN FRONTAL IMPACTS

<b>Frontal Force Impact Tolerance of the Human Thorax (P-67)</b> .....	<b>39</b>
L. Patrick	
<b>Thoracic Response to Blunt Frontal Loading (P-67)</b> .....	<b>51</b>
C. Kroell	
<b>Mechanisms of Injuries to Unrestrained Drivers in Head-On Collisions (690811)</b> .....	<b>81</b>
G.Voigt, K. Wilfert	
<b>Deflection of the Human Thorax Under Sternal Impact (700400)</b> .....	<b>93</b>
A. Nahum, C. Gadd, D. Schneider, C. Kroell	
<b>Volunteer, Anthropometric Dummy, and Cadaver Responses with Three and Four Point Restraints (710079)</b> .....	<b>105</b>
L. Patrick, K. Trosien	
<b>Impact Tolerance and Response of the Human Thorax (710851)</b> .....	<b>131</b>
C. Kroell, D. Schneider, A. Nahum	
<b>Thoracic Tolerance to Whole-Body Deceleration (710852)</b> .....	<b>183</b>
H. Mertz, C. Gadd	
<b>Analysis of Chest Impact Response Data and Scaled Performance Recommendations (741188)</b> .....	<b>207</b>
R. Neathery	

<b>Three-Point Harness Accident and Laboratory Data Comparison (741181)</b> .....	225
L. Patrick, N. Bohlin, A. Anderson	
<b>Impact Tolerance and Response of the Human Thorax II (741187)</b> .....	271
C. Kroell, D. Schneider, A. Nahum	
<b>Results of 49 Cadaver Tests Simulating Frontal Collision of Front Seat Passengers (741182)</b> .....	311
G. Schmidt, D. Kallieris, J. Barz, R. Mattern	
<b>Three-Point Belt Induced Injuries: A Comparison Between Laboratory Surrogates and Real World Accident Victims (751141)</b> .....	317
J. Cromack, H. Ziperman	
<b>Thorax of 3-Point Belt Wearers During a Crash (Experiments with Cadavers) (751148)</b> .....	341
A. Fayon, C. Tarriere, G. Walfisch, C. Got, A. Patel	
<b>Neck and Thorax Tolerance Levels of Belt-Protected Occupants in Head-On Collisions (751149)</b> .....	371
G. Schmidt, D. Kallieris, J. Barz, R. Mattern, J. Klaiber	
<b>Cadaver Skeletal Response to Blunt Thoracic Impact (751150)</b> .....	405
A. Nahum, D. Schneider, C. Kroell	
<b>Thoracic Impact Response of Live Porcine Subjects (760823)</b> .....	441
D. Viano, C. Warner	
<b>Comparative Thoracic Impact Response of Living and Sacrificed Porcine Siblings (770930)</b> .....	475
D. Viano, C. Kroell, C. Warner	
<b>Sensitivity of Porcine Thoracic Responses and Injuries to Various Frontal and A Lateral Impact Site (780890)</b> .....	557
D. Viano, C. Warner, K. Hoopes, C. Mortenson, R. White, C. Artinian	
<b>Correlation Between Thoracic Lesions and Force Values Measured at the Shoulder of 92 Belted Occupants Involved in Real Accidents (780892)</b> .....	575
J. Foret-Bruno, F. Hartemann, C. Thomas, A. Fayon, C. Tarriere, C. Got, A. Patel	
<b>Impact Force-Deflection of the Human Thorax (811014)</b> .....	587
L. Patrick	
<b>Interrelationship of Velocity and Chest Compression in Blunt Thoracic Impact to Swine (811016)</b> .....	613
C. Kroell, M. Pope, D. Viano, C. Warner, S. Allen	
<b>The Influence of Impact Energy and Direction on Thoracic Response (831606)</b> .....	629
G. Nusholtz, J. Melvin, P. Lux	

<b>A Biomechanical Analysis of Head, Neck, and Torso Injuries to Child Surrogates Due to Sudden Torso Acceleration (841656)</b> .....	<b>655</b>
P. Prasad, R. Daniel	
<b>Thoraco-Abdominal Response to Steering Wheel Impacts (851737)</b> .....	<b>671</b>
G. Nusholtz, P. Kaiker, D. Huelke, B. Suggitt	
<b>Validity of Thoracic Injury Based on the Number of Rib Fractures (856027)</b> .....	<b>719</b>
J. Verriest, A. Chapon	
<b>Chest Deflection Characteristics of Volunteers and Hybrid III Dummies (861884)</b> .....	<b>729</b>
S. Backaitis, A. St-Laurent	
<b>Interaction of Human Cadaver and Hybrid III Subjects with a Steering Assembly (872202)</b> .....	<b>739</b>
D. Schneider, A. Nahum, D. Dainty, J. Awad, S. Forrest, R. Morgan, R. Eppinger, J. Marcus,	
<b>Behaviour of Human Surrogates Thorax Under Belt Loading (902310)</b> .....	<b>755</b>
D. Cesari, R. Bouquet	
<b>Thoracic Deformation Contours in a Frontal Impact (912891)</b> .....	<b>765</b>
N. Yoganandan, D. Skrade, F. Pintar, J. Reinartz, A. Sances, Jr.	
<b>Thoracic Injury Assessment of Belt Restraint Systems Based on Hybrid III Chest Compression (912895)</b> .....	<b>783</b>
J. Horsch, J. Melvin, D. Viano, H. Mertz	
<b>The Biofidelity of EUROSID 1 and BIOSID (922518)</b> .....	<b>807</b>
D. Kallieris, R. Mattern, A. McIntosh, F. Boggasch	
<b>Thoracic Biomechanics with Air Bag Restraint (933121/P-269)</b> .....	<b>823</b>
N. Yoganandan, F. Pintar, D. Skrade, W. Chmiel, J. Reinartz, A. Sances, Jr.	

### **SECTION 3: BIOMECHANICS, IMPACT RESPONSE AND TRAUMA ASSESSED WITH VOLUNTEERS, CADAVERS, ANIMAL AND MECHANICAL SURROGATES IN LATERAL IMPACTS**

<b>Biomechanics of Lateral Thoracic Injury (P-67)</b> .....	<b>837</b>
J. Melvin	
<b>Side Impact Response and Injury (766064)</b> .....	<b>843</b>
J. Melvin, D. Robbins, R. Stalnaker	

<b>Thoraco-Abdominal Response and Injury (801305)</b> .....	<b>853</b>
G. Nusholtz, J. Melvin, G. Mueller, J. MacKenzie, R. Burney	
<b>Influence of Arm Position on Thoracic Injuries in Side Impact (811007)</b> .....	<b>893</b>
D. Cesari, M. Ramet, J. Bloch	
<b>Side Impact – The Biofidelity of NHTSA’s Proposed ATD and Efficacy of TTI (861877)</b> .....	<b>921</b>
R. Morgan, J. Marcus, R. Eppinger	
<b>Contribution and Evaluation of Criteria Proposed for Thorax-Abdomen Protection in Lateral Impact (876040)</b> .....	<b>935</b>
F. Brun-Cassan, Y. Pincemaille, P. Mack, C. Tarriere	
<b>Injury and Response of the Thorax in Side Impact Cadaveric Tests (933127)</b> .....	<b>949</b>
J. Cavanaugh, Y. Zhu, Y. Huang, A. King	
<b>Regional Tolerance of the Shoulder, Thorax, Abdomen and Pelvis to Padding in Side Impact (930435)</b> .....	<b>973</b>
J. Cavanaugh, Y. Huang, Y. Zhu, A. King	

## **SECTION 4: DUMMIES, MODELING, TEST PROCEDURES AND INSTRUMENTATION USED FOR FRONTAL AND LATERAL IMPACT TESTING**

<b>Development of Dummy and Injury Index for NHTSA’s Thoracic Side Impact Protection Research Program (840885)</b> .....	<b>983</b>
R. Eppinger, J. Marcus, R. Morgan	
<b>Evaluation of the SID Dummy and TTI Injury Criterion for Side Impact Testing (872208)</b> .....	<b>1013</b>
D. Viano	
<b>Biofidelity of the Hybrid III Thorax in High-Velocity Frontal Impact (880718)</b> .....	<b>1031</b>
J. Horsch, D. Schneider	
<b>Biosid Update and Calibration Requirements (910319)</b> .....	<b>1039</b>
M. Beebe	
<b>Development of an Advanced ATD Thorax System for Improved Injury Assessment in Frontal Crash Environments (922520)</b> .....	<b>1047</b>
L. Schneider, M. Haffner, R. Eppinger, M. Salloum, M. Beebe, S. Rouhana, A. King, W. Hardy, R. Neathery	
<b>Finite Element Simulation of the Occupant/Belt Interaction: Chest and Pelvis Deformation, Belt Sliding and Submarining (933108)</b> .....	<b>1075</b>
D. Song, P. Mack, C. Tarriere, F. Brun-Cassan, J. Le Coz, F. Lavaste	

<b>Comparison of Modeling Techniques for Flexible Dummy Parts (933116)</b> .....	1097
W. Koppens, H. Lupker, C. Rademaker	

## SECTION 5: METHODS OF APPRAISAL AND PREDICTIVE FUNCTIONS

<b>Prediction of Thoracic Injuries as a Function of Occupant Kinematics (796034)</b> .....	1109
D. Robbins, R. Lehman, K. Augustyn	
<b>Proposal for a Thorax Tolerance Level in Side Impacts Based on 62 Tests Performed With Cadavers Having Known Bone Condition (821157)</b> .....	1119
J. Sacreste, F. Brun-Cassan, A. Fayon, C. Tarriere, C. Got, A. Patel	
<b>Side Impact Data Analysis (826034)</b> .....	1137
R. Eppinger, R. Morgan, J. Marcus	
<b>Human Response to and Injury from Lateral Impact (831634)</b> .....	1145
J. Marcus, R. Morgan, R. Eppinger, D. Kallieris, R. Mattern, G. Schmidt	
<b>A Procedure for Normalizing Impact Response Data (840884)</b> .....	1159
H. Mertz	
<b>Predictive Functions for Thoracic Injuries to Belt Wearers in Frontal Collisions and Their Conversion into Protection Criteria (851722)</b> .....	1167
F. Walfisch, F. Chamouard, D. Lestrelin, C. Tarriere, F. Brun-Cassan, P. Mack, C. Got, F. Guillon, A. Patel, J. Hureau	
<b>Interrelationship of Velocity and Chest Compression in Blunt Thoracic Impact to Swine II (861881)</b> .....	1187
C. Kroell, S. Allen, C. Warner, T. Perl	
<b>The Viscous Criterion - Bases and Applications of an Injury Severity Index for Soft Tissues (861882)</b> .....	1211
I. Lau, D. Viano	
<b>On the Development of a Deformation Measurement System and Its Application Toward Developing Mechanically Based Injury Indices (892426)</b> .....	1231
R. Eppinger	
<b>Biomechanical Response and Injury Tolerance of the Thorax in Twelve Sled Side Impacts (902307)</b> .....	1239
J. Cavanaugh, T. Walilko, A. Malhotra, Y. Zhu, A. King	

<b>Hybrid III Sternal Deflection Associated with Thoracic Injury Severities of Occupants Restrained with Force-Limiting Shoulder Belts (910812)</b> .....	<b>1255</b>
H. Mertz, J. Horsch, G. Horn, R. Lowne	
<b>Displacement Responses of the Shoulder and Thorax in Lateral Sled Impacts (933124)</b> .....	<b>1271</b>
A. Irwin, T. Waliko, J. Cavanaugh, Y. Zhu, A. King	
<b>Injury Assessment Values for Hybrid III Chest Measurements in Frontal Impacts</b> .....	<b>1281</b>
H. Mertz	
<b>Appendix 1:</b> .....	<b>1283</b>
Recommended Reading (Due to space limitations, these valuable technical publications were not reprinted in this book, instead abstracts of each paper are included.)	
<b>Appendix 2 :</b> .....	<b>1295</b>
Related Reading (Contains a listing of publications that contain relevant information on the subject matter. The list was selected by the members of the review panel who assisted in the development of PT-45. Due to space constraints, abstracts to these papers are not included.)	
<b>Index</b> .....	<b>1299</b>