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HIGHWAY SAFETY RESEARCH INSTITUTE
INSTITUTE OF SCIENCE AND TECHNOLOGY
THE UNIVERSITY OF MICHIGAN

NATIONAL ACCIDENT SAMPLING SYSTEM

TRAINING MATERIALS FOR
ACCIDENT RECONSTRUCTION

INSTRUCTOR'S MANUAL

Volume III

by:

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PREFACE

This Instructor's Manual is Volume III of the training materials developed by the staff of The University of Michigan's Highway Safety Research Institute for investigators in the National Highway Traffic Safety Administration (NHTSA) National Accident Sampling System (NASS). Volume I is a Reference Manual and Volume II is a Student Notebook. This volume contains lesson outlines.

The course was conducted for senior NASS investigators in May 1979. A course evaluation was reported separately (Report No. UM-HSRI-79-81).

Daily Calendar

MONDAY	8:30	1. Introduction	-Campbell & McDole
	9:00	2. Review Exercises	-McDole
	9:45	Break	
	10:00	3. Physics & Dynamics	-Hess
	11:45	Lunch	
	12:45	Lesson 3, cont.	
	2:45	Break	
	3:00	9. Data Presentation	-Cooley
	4:45	End of Day	
TUESDAY	8:30	5. Vehicle Force-Deflection	-Campbell
	9:30	Break	
	9:45	4. Vehicle Dynamics	-Winkler
	11:45	Lunch	
	12:45	10. Classroom Reconstruction	-Hess
	2:45	Break	
	3:00	8. Vehicle Examination	-Cooley
	4:45	Dinner	
7:00	8L. Vehicle Examination Lab	-Cooley @ HSRI	
WEDNESDAY	8:30	Classical Reconstruction, cont.	
	10:00	Break	
	10:15	Classical Reconstruction, cont.	
	11:45	Lunch	
	12:45	6. Skid Marks	-Cooley
	2:45	Break	
	3:00	7. Scene Examination	-Cooley
	4:45	Dinner	
7:00	7L. Scene Examination Laboratory	-Cooley @ HSRI	
THURSDAY	8:30	11. Applications of Classical Accid. Recon.	-Hess
	10:00	Break	
	10:15	Applications, cont.	
	11:45	Lunch	
	12:45	Applications, cont.	
	2:45	Break	
	3:00	11E Exercises	-Hess, Staff
	4:00	Dinner	
7:00	CRASH Lab.	-Hess @ HSRI	

FRIDAY

8:30 CRASH Lab, cont.
10:00 12. CRASH Lab Discussion
11:45 Lunch
12:45 13. Collision Severity Measures
1:45 Break
2:00 14. Final Examination
3:30 15. Summary & Closure
4:00 Dismissal

-@ HSRI
-@ Chrysler Center

Advanced Accident Reconstruction Lesson Schedule

	8am	9	10	11	12	1	2	3	4	5	7	8	9pm
M		1 Introduction	2 Review Exercises	3 Physics and Dynamics				9 Physics and Dynamics cont.	9 Data Documentation				
T.		5 Vehicle Force-Deflection	4 Vehicle Dynamics				10 Classical Reconstruction	8 Vehicle Examination				8 Vehicle Exam. Lab.	
W							6 Skid Marks	7 Scene Examination				7 Scene Exam. Lab.	
T							11 Applications cont.	11E Exercises				11L CRASH Lab	
F							13 Collision Severity Measures	14 Final Examination	15 Summary & Closure				

List of Lessons

Unit I. Course Overview

1. Course Introduction
2. Review Exercises

Unit II. Basic Principles

3. Physics and Dynamics
4. Vehicle Dynamics
5. Vehicle Force-Deflection Characteristics
6. Skid Marks and Analysis

Unit III. Data Collection and Documentation

7. Scene Inspection
- 7L. Scene Inspection Laboratory
8. Vehicle Inspection
- 8L. Vehicle Inspection Laboratory
9. Data Documentation

Unit IV. Reconstruction Techniques

10. Classical Reconstruction
11. Applications of Classical Accident Reconstruction
- 11E. Classical Reconstruction Exercises
- 11L. CRASH Laboratory
12. CRASH Laboratory Discussion
13. Collision Severity Measures

Unit V. Summation

14. Final Examination
15. Summary and Closure

Advanced Accident Reconstruction

Lesson Outline

Lesson No. 1, Introduction

Presented by: Kenneth L. Campbell
Thomas L. McDole
Highway Safety Research Institute

Description:

The introduction to the course. Presented will be the overall course organization, course objectives, lesson schedule, and calendar, distribution of lesson material, other course organizational information, and an overview of Accident Reconstruction.

Topics:

Welcome - T. McDole
Course Organization
Course Materials
Announcements
Word from Washington - S. Lee
Course Introduction - K. Campbell
Course Objectives
Overview of Accident Reconstruction

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 2, Review Exercises

Presented by: Thomas L. McDole

Description:

A review of the pre-course student mathematical exercises. The graded exercises will be returned to the student and problem areas will be discussed. The solutions to the problems will be presented and student's questions answered.

Topics:

Discussion of the graded pre-course exercises.

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 3, Physics and Dynamics

Presented by: Robert L. Hess, Ph.D.

Description:

An introduction to the basic principles of physics and dynamics as they apply to accident reconstruction.

Topics:

Mathematical Background

- Coordinate systems
- Lines and points in a plane
- Vectors

Plane Kinematics of a Particle

- Vector position and displacement
- Velocity
- Momentum and Force

Plane Kinematics of a Rigid Body

- Angular Velocity
- Rotation
- Centroids
- Acceleration

Kinematics of a Body in Plane Motion

- Center of Mass
- Newton's Axiom
- Rectilinear Motion of a Rigid Body
- Plane Motion of a Rigid Body
- Vehicle Force System

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 4, Vehicle Dynamics

Presented by: Christopher Winkler

Description:

An overview of three-dimensional real-world vehicle dynamics including vehicle handling, braking, and traction as they apply to accident causation and investigation.

Topics:

Definitions

- In-plane and out-of-plane motions

- Motor vehicle components which influence braking and handling

Tire traction and compliance

Handling

- Steady turning, normal and limit

- Directional response to steering

- Influence of wind and road disturbance

Braking

- Brake torque and force distribution

- The steady braking process

- Limit braking and directional stability

- Influence of road surface and tires

Accelerating

- Turning on a reduced friction surface

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 5, Vehicle Force - Deflection Characteristics

Presented by: Kenneth L. Campbell

Description:

An overview of vehicle force-deflection characteristics as they apply to accident reconstruction. These characteristics are a measure of the energy required to crush the vehicle.

Topics:

- Energy Considerations
- Energy Balance and Terms
- Estimating Energy Absorbed
- Considerations in Measuring Crush

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 6, Skid Marks and Analysis

Presented by: Peter Cooley

Description:

A presentation on the practical aspects of describing and measuring skid and other pavement marks and on the estimating of changes of vehicular velocity based on skid distance and coefficient of friction.

Topics:

- Importance of Tiremarks and Roadway Evidence
- Overlapping Skidmarks
- Curved Skidmarks
- Skip Skids
- Gaps in Skidmarks
- Acceleration Marks
- Variable Skidmarks
- Tread Pattern Marks and Striations
- Point of Impact
- Tire Tread Imprints
- Scuff Marks
- Scratches
- Gouges
- Ruts
- Furrows
- Holes and Mounds
- Debris
- Speed from Skidmarks

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 7, Scene Inspection

Presented by: Peter Cooley

Description:

A presentation on the information available at an accident scene with techniques utilized to identify the scene elements necessary for accident reconstruction and to review methods of recording these data.

Topics:

- Scene examination overview
- Measurement Benchmarks
- Measurement Equipment
- Vehicle Final Rest Position
- Roadway Examination
- Road Characteristics
- Traffic Controls
- Off-road Features
- Environmental Factors

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 7L, Scene Inspection Laboratory

Presented by: Peter Cooley

Description:

A laboratory session to accompany the presentation on Scene Inspection. Available will be several accident scenes for the student to observe, measure, and work.

Topics:

Observation of accident scenes

Relevant Roadway Features

Skid marks demonstration

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 8, Vehicle Inspection

Presented by: Peter Cooley

Description:

A presentation to identify the vehicle-related data elements necessary for accident reconstruction and to review the methods utilized in observing, interpreting, and recording these data.

Topics:

- I. General Vehicle Factors
- II. On-scene Information
- III. Vehicle Identification
- IV. Tow Operator Practices and Storage
- V. Exterior Damage Assessment
- VI. Vehicle Exterior Examinations
- VII. Vehicle Impact Orientations
- VIII. Vehicle Field Forms

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 8L, Vehicle Inspection Laboratory

Presented by: Peter Cooley

Description:

A laboratory session to accompany the presentation on Vehicle Inspection. Available will be several accident-involved vehicles for the student to observe, measure, and record.

Topics:

Observe and measure accident involved vehicles.

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 9, Data Documentation

Presented by: Peter Cooley

Description:

A presentation to review the techniques available to the investigator for observing and recording the necessary data for accident reconstruction. Techniques to be covered include measurement techniques, marking and mapping techniques, photographic aids, and interviewing techniques.

Topics:

- Investigator as an Observer
- Field Data Recording Methods
- Symbols for Documenting Crash Scene
- Field Measurements
- Sketching and Drawing To Scale
- Photography

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 10, Classical Reconstruction

Presented by: Robert L. Hess

Description:

To provide an introduction to calculation used in accident reconstruction, to illustrate the steps necessary to perform a reconstruction, to provide an introduction to computer-assisted reconstruction calculations, and to illustrate the logic of various computer-oriented reconstruction programs and sub-programs.

Topics:

- Kinematic Equations of Motion Applied to Vehicle Trajectory
- Simplified Marguardt Equations
- Step-by-Step Integration
- Plots of Linear and Angular Velocity
- Trajectory Simulation
- Kinematic Equations Applied to Impact

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 11, Applications of Classical Accident Reconstruction

Presented by: Robert L. Hess

Description:

A discussion of the application of classical, hand calculations to accident reconstruction and of the application of CRASH to crash configurations, of the sensitivity of CRASH results to certain input parameters and of operational problems encountered in using CRASH.

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 11E, Classical Reconstruction Exercises

Presented by: Kenneth L. Campbell

Description:

A structured exercise laboratory session for the group solving of basic reconstruction problems.

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 11L, CRASH Lab.

Presented by: Robert L. Hess

Description:

A laboratory session devoted to individual or small group solution of reconstruction problems using CRASH and other problem solving techniques. Input data will come from either instructor generated problems or from student-generated data based on previous laboratory sessions.

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 12, CRASH Lab Discussion

Presented by: Robert L. Hess

Description:

A discussion of the CRASH Laboratory Session

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 13, Collision Severity Measures

Presented by: Kenneth L. Campbell

Description:

The need, definition, and uses of information on collision severity are described in order to instill a sense of "purpose" in the investigator.

Topics:

- Need for Collision Severity
- Definition of Collision Severity
- A Model
- Measures of Collision Severity
- Applications
- Examples

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Advanced Accident Reconstruction

Lesson Outline

Lesson No. 14, Final Examination

Presented by: Thomas L. McDole

Description:

A final course examination

Advanced Accident Reconstruction

Lesson Outline

Lesson No. 15, Summary and Closure

Presented by: Thomas L. McDole
Kenneth L. Campbell

Description:

Final class meeting, closing remarks, course evaluation,
etc. as necessary to wrap-up the course.

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