For example, reports on several accidents or even experimental crash tests showing that front-wheel-drive mini-compacts snag on longitudinal railing systems or that they fail to activate breakaway devices might be sufficient to indicate the need for further research, development and, possibly, a retrofit program. Exposure data or information on successful performance might not be particularly important for this purpose. It should be pointed out that practical details (e.g., coordination and funding) still need to be developed for a system of in-service evaluation like that suggested in Report 230.

o Data not specifically related to accidents can also be of value. For example, statistics on automobile sales might point to a trend such as the increasing number of mini-compacts, from which potential problems can be anticipated and, if possible, avoided before they occur.

o Data that can be evaluated statistically can be useful in several ways. Ideally, such data would be recorded for all incidents (drive-aways as well as reported accidents) on certain installations over a prolonged period. This information could be used to establish priorities for research and development expenditures or to justify the need for a major rehabilitation program to correct a particular problem. An example would be bridge railing transitions. Accident statistics gathered during the 1960s indicated a disproportionate number of fatalities associated with inadequate transitions, and subsequent attention to this problem resulted in a significant reduction.

o Accident data are also needed to establish improved crash testing procedures and evaluation criteria. The test conditions specified in Report 230 are based on judgment; they are idealized and are neither average, typical, maximum nor worse-case conditions. Nevertheless, the values selected might be viewed with greater confidence if they were backed up by more comprehensive data than are currently available. Similarly, the flail space concept for assessing risk to the occupant is new and will need validation and, possibly, revision based on insight gained from accident data.

In conclusion, the types of data needed on safety appurtenance accidents are diverse and, in considering our needs and methods of filling them, we should take care not to devise plans for collecting more than is needed for a particular objective

COMPUTER SIMULATIONS--LIMITATIONS AND DATA NEEDS

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Computer simulation can be a useful tool to provide input to the general problem of collision severity. Significant advances in simulation capability have been made in recent years and a reasonable degree of success has been achieved for many impact configurations. However, there are still several situations for which it is difficult to perform satisfactory simulations. This presentation focuses on some of the current major limitations of analytical simulation as applied to vehicle collisions with roadside features.

The definition of simulation is restricted here to the prediction of a response of the vehicle and roadside obstacle in a crash event; occupant response is not included.

An outline of various areas of simulation difficulty and the causes of difficulty is presented in Table 2. The causes may be divided into three categories:

1. Required input data not readily available,
2. difficulty in quantifying required input because of large variability in physical data of current vehicle fleet, and
3. proper modeling in some instances results in prohibitive costs because of the complexity of the model required to simulate the event (factors contributing to the costs associated with simulation include model development and validation; input data compilation and/or generation; operational costs of computer program; and review, evaluation and display of computer output).

Table 2: Limitations of Computer Simulations of Appurtenance Collisions

Areas of Simulation Difficulty	Causes of Difficulty
1. CMB Impact	Tire-road intersection at steep barrier angles Tire sidewall-rim deformation properties--stiffness, strength (axle-wheel-suspension system damage)
2. Impact of post-rail systems	Post-foundation interaction Snagging
3. Impact with terminals	Texas twist - vaulting behavior BCT - spearing, tripping action
4. Traversal of high curb-like obstacles; high curbs; timbers in construction barriers	Suspension bottoming characteristics Tire properties at severe deformation--stiffness, blowout loads
5. Shifting loads	Swinging loads--packing procedures (spacing), cargo stiffness, vehicle wall stiffness Sloshing loads--partially-filled tanker trailers Secured cargo--fastener strength, cargo module size and location in truch Passenger shift--buses

Table 2: Limitations of Computer Simulations of Appurtenance Collisions

Areas of Simulation Difficulty	Causes of Difficulty
6. Impact with sign posts, liminarie supports	Vehicle wrap-around locally--snagging; details of post-vehicle interface geometry Localized deformation property of vehicle Post-soil interaction Breakaway supports--limiting dynamic strength of supports
7. Crash cushion impact	3-D effects--ramping or nosing--relative interface geometry and c.g. heights of vehicle and cushion; curbs Characterization of cushion module deformation properties--stiffness, rate effects, fracture, mass loss
8. Articulated vehicles	Constraint conditions at fifth wheel--slack, stiffness
9. High center of gravity vehicles	Rollover resistance--suspension tension properties, slack; suspension compressive bottoming properties
10. Vehicle deformation properties	Function of position on exterior envelope
11. Simulation output	Vehicle accelerations--not as accurate as kinematics--correlation with occupant risk

LIMITATIONS ASSOCIATED WITH ANTHROPOMETRIC DUMMIES

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Due to current anthropometric dummy technology limitations, dummy response data from crash tests do not provide a sufficient linkage with roadside feature collision severity. As shown in Table 3, limitations can be categorized into three areas: surrogate representativeness, surrogate response interpretation and relationship between surrogate response and performance of roadside feature.

With regard to representativeness, current dummies were developed for vehicle restraint evaluations in which the vehicle experiences a highly directional and abrupt velocity change such as a head-on collision into a rigid barrier. Their use in evaluating roadside features in which the collision may be prolonged over several hundred millisecond duration, where there may be multiple vehicle impacts, where the vehicle may be redirected and where the dummy may be unrestrained is certainly questionable. Of particular concern is the current dummy biofidelity for crashes in which large side forces are introduced, such as a typical longitudinal guardrail redirectional test.

Table 3: Limitations Associated with the Use of Anthropometric Dummies to Evaluate Roadside Countermeasures

Limitations	Issues of Concern
Surrogate representativeness	Biofidelity--general indication of collision severity seen by occupant, not intended for highly specific lesion prediction/assessment Kinematics Occupant population Current 50th percentile dummies Hybrid II (Part 572)--restraints development and vehicle safety evaluations, FMVSS testing, thought undesirable for side restraint development Hybrid III--improved chest and neck characteristics, thought undesirable for side restraint development; dummies for side impacts--being evaluated, injury measures undecided, matching responses from dummies to injuries in real-world accidents