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# Railroad Freight Loss and Damage: Concepts and Prevention

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## ABSTRACT

This report presents an economic and engineering overview of railroad freight loss and damage. The engineering concepts and preventive techniques that are applicable to an orderly solution of the loss and damage problem are described and examined.

The report specifically itemizes the major loss and damage categories; specifies the hardware and equipment deficiencies which impact railrcar loss and damage; recommends a product packaging system for the railcar environment; describes physical and electronic equipment to prevent cargo loss (theft); and examines the transportation environment along with the railcar cushioning devices required for railcar and lading protection.

## TABLE OF CONTENTS

## I FREIGHT LOSS AND DAMAGE CLAIMS

Although precise statistical data do not yet exist, the office of Policy Review of the U.S. Department of Transportation estimates that the yearly losses due to damage in shipment total three billion dollars.* This figure includes the indirect factors such as the cost of processing claims. It does not include such intangibles as added inventory costs and the loss of customer goodwill.

In 1970 the direct cost to railroads for loss and damage was $228 million, according to the released figures by the Association of American Railroads. The yearly loss and damage bill for 1969 was about 50 percent higher than the 1961 level. And for 1969, this economic confrontation amounted to approximately one-third of the railroads industry's net income.**

During the past many years, major innovations have occurred in the damage prevention area. Today many freight cars have cushioned underframes and end-of-car cushioning devices; equipment with interior stowing devices; specially equipped cars for specialized cargo are available; impact recorders are installed; and packaging and loading studies are performed for the shippers confronted with severe damage problems

*Office of Policy Review, "Freight Loss and Damage", 1971.

** "Railroad Freight Losss and Damage Prevention." Railway Systems and Management Association, Chicago, Illinois, 1969.

in the distribution environment. Yet, in spite of these varied measures and techniques, the railroad freight damage costs are not headed downward nor are there apparent inroads into the loss problem.

For the decade 1958 - 1967, when the revenue ton miles advanced by 30 percent, the freight loss and damage claims increased by almost 55 percent. The $108 million paid out in 1958 advanced to $167 million in 1967, and on to over $228 for 1970. Although most railroads have damage reducing programs, the claims costs continue to escalate. The railroad industry has lost billions of dollars through freight loss and damage. The category of improper handling accounts for 60 percent of the total freight claim payout. A claim is assigned to improper handling when the cause of the damage cannot be assigned to any specific cause during the claims investigation.

In a prepared talk to the Railway Systems and Management Association, the Manager of Claims and Insurance for Burlington Industries underlined the fact that at present the carrier freight classification committees cannot provide package specifications that will insure the damage-free arrival of the packaged product. The classification specifications have been found to be unsatisfactory; yet, the carriers rely heavily on the classification committee specifications.*

*"The Shipper Views the Carriers Approach to Loss and Damage", C.E. Barnes, Railway Systems and Management Association, Illinois, 1969.

As "common carriers", the transportation companies must accept any shipment of any product offered to them (with some few exceptions). By law, the transportation companies are required to publish freight tariffs. The freight tariffs describe the services, name the conditions under which the services will be performed, and state the price for the services in terms of a freight rate in cents per 100 pounds or other unit of weight or volume. The carriers publish the freight tariffs in classifications, in which articles that have similar transportation characteristics are grouped together into classes. These characteristics include value, density, fragility, potential for damaging other freight or the carriers equipment, and frequency and direction of movement. The issue, published by the railroads, is called the "Uniform Freight Classification". Each "Classification" has one or more rules to designate the type of packaging required. The basic regulation of the railroads governing fiberboard boxes is Rule 41. The Department of Transportation establishes packaging standards under Rule DOT-12B.

Although there are many new types of packaging that may provide superior product protection, many of these new packaging materials do not conform to the carriers' regulations. The shipper may propose that his new packaging be recognized in the rail classifications. For this purpose, as outlined in the railroads' Rule 49, printed proposal forms are supplied by the railroads' Uniform Classification Committee. Upon approval by the Classification Board, the new package is included in the appropriate classification, and then becomes available to any interested shipper.

The available facts and figures for cargo loss and damage claims are somewhat less than helpful in assessing the magnitude and complexity of those areas of loss and damage which can be prevented or minimized. In response to the lack of a comprehensive and uniform loss and damage information system, the Federal Transportation Regulatory Agencies have initiated, in 1972, a system of Quarterly Loss and Damage Reports which will require common carriers to submit information defining cargo loss and claim data. The Association of American Railroads (AAR) has also recognized the requirement for more precise national statistics for freight loss and damage. The AAR plans to implement, in 1973, a National Freight Loss and Damage Prevention Data System for the detailed study of commodity, shipper or carrier-oriented problems.

The development of a damage prevention information system has some special problems, such as the built-in time lag in which to file a claim (nine months from delivery).

In addition to this time lag, approximately 50 percent of the individual railroad's claim data does not originate within its organization, but originates from another carrier. There is also the incomplete or inaccurate information collected. It appears that an information system for the productive analysis of the claims data will be complex.

Various federal statutes and court decisions governs the carrier liability for freight loss and damage. The effect of these rules and regulations is that the carrier is fully liable for the damage or loss of transported goods.

The railroads annually handle 2.5 million freight claims. The large majority of loss and damage claims are voluntarily settled. It appears that probably 80 to 90 percent of the claims are or can be processed by the carrier with such documentary evidence as the bill of lading, the delivery receipt, the freight bill, the shipper's original invoice or certification of the commodity price, and the carrier record of investigation (OS and D Report).

When the shipper seeks loss and damage relief, it then becomes a matter for the court. At present, the Court's function is to determine whether the cargo casualty occurred in transit and to determine the actual value of the loss caused by the carrier.*

*Interstate Commerce Commission, "Rules, Regulations, and Practices of Regulated Carriers with Respect to the Processing of Loss and Damage Claims", Ex Parte No. 263, 1972.

Although the existence of a loss and damage problem is established, there is no common agreement on the economic magnitude of the problem. This disparity led the Senate Committee on Small Business, during their investigation of cargo security, to request a report from the Congressional Library Research Service on the cargo theft and pilferage losses. The Congressional Library research group reported that the cargo theft and pilferage losses for the rail carriers for 1970 amounted to $250 million. This figure excludes such indirect costs as the processing of claims and the cost of lost business and profits.

## II THE ECONOMIC METHODOLOGY FOR EVALUATING FREIGHT LOSS AND DAMAGE

On account of the need to better describe the extent of cargo loss, the Department of Transportation awarded a contract to Braddock, Dunn and McDonald (BDM) to quantify the cargo loss problem.*

The informational base for the BDM study was derived from personel interviews, a sampling process assisted by questionnaires, and freight claim data. The study implies that the carrier data, by itself, distorts the measure of cargo loss; and, therefore, this shortcoming must be corrected from the shipper claims data. However, the shippers do not have an agency which collects and analyzes claims data. In spite of this deficiency, the BDM study states that the method of stratified sampling provides a reasonably accurate method for collecting shipper data. (Stratification is similar to simple random sampling). The insurance underwriters (AIMU) were contacted, but the insurance industry provided no data that defined cargo loss in detail for mode, cause and commodity. The new ICC Quarterly Loss and Damage Reports also provided meager data.

A summary of the railroad cargo loss cost, based on the

*Department of Transportation, "An Economic Model of Cargo Loss: A Method for Evaluating Cargo Loss Reduction Programs," DOT P 5200.3,1972.

BDM economic model derived from their stratified sampling technique, is shown in Table 1.

According to the study, the railroad cargo loss cost in Table 1 is conservative as the claim processing costs do not include overhead or burden, and it was also difficult to estimate the cargo liability premiums because the cargo liability insurance is usually included in a total insurance package. Also, the indirect cost estimates are low; various officials estimate the indirect losses as high as 2 to 5 times the claims paid. Some of the estimates, according to the Senate Small Business Committee, are included below:*

Carrier Indirect Cost = $2-5/$1 claim paid
Shipper Indirect Cost = $5-7/$1 claim received
Library of Congress Study = $4.5/$1 claim paid

Table 2 itemizes the distribution of claims by commodity for the railroads; the distribution of cargo loss and damage are compiled from the 1970 FCD - 1 Report of the Association of American Railroads.

The commodity-cause data, presented in Table 2, are further summarized below:

Figure 1 summarizes the freight revenue by mode for comparison with the commodity-cause loss data.

*U.S. Senate Select Committee on Small Business, "Cargo Theft Joint Conference", Part 4, 1971

Figure 2 describes the distribution of the cargo loss by mode. The cost ratio was calculated as the ratio of total loss to gross revenue. According to the study, this is a better measure of loss than the claims loss ratio commonly used by the industry.

Figure 3 itemizes the distribution of theft-related losses by mode.

Figure 4 summarizes the cause of loss and itemizes the theft-related portion of loss for each mode.

The Association of American Railroads Freight Loss and Damage statement for 1970 is also included, as Figure 5.

Table 1

SUMMARY OF RAILROAD CARGO LOSS COST

| | |
|---|---|
| Carrier Direct Cost | = $302,278,865 |
| Carrier Indirect Cost | = $ 79,335,965* |
| Total Carrier Cost | = $381,614,830 (82%) |
| S/C Direct Cost | = $ 4,655,520 |
| S/C Indirect Cost | = $ 79,335,965* |
| Total S/C Cost | = $ 83,991,485 (18%) |
| Total Cost | = $465,606,315 |

*Shipper/Consignee (S/C) indirect costs are assumed to be equal to carrier indirect costs, on a claim-by-claim basis.

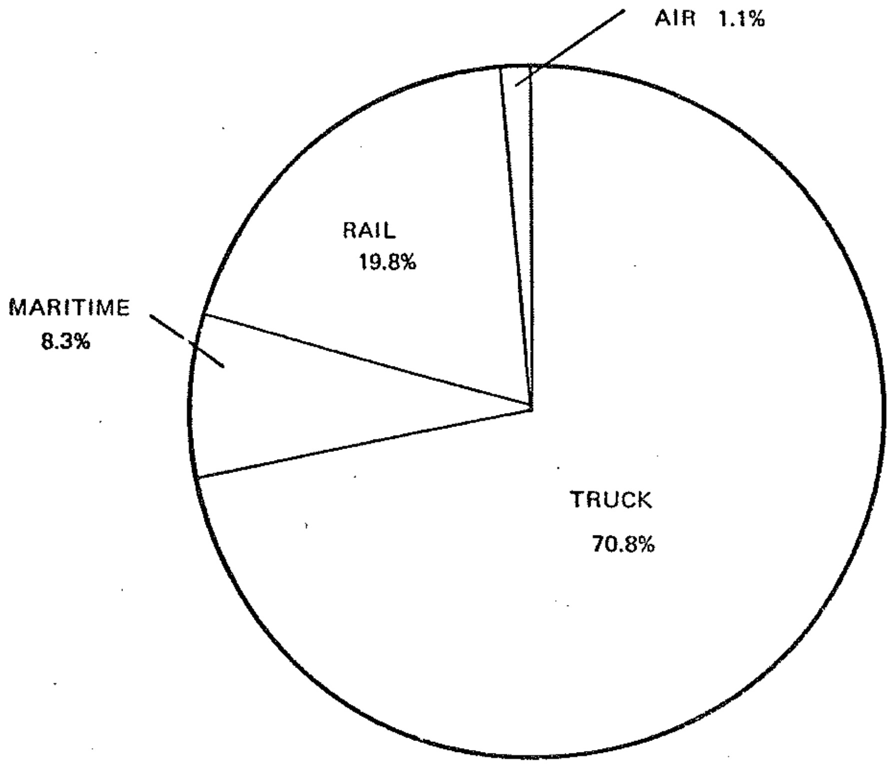
Source: Braddock, Dunn and McDonald DOT P 5200.3, 1972

Table 2

GROSS CLAIMS PAID BY CAUSE & COMMODITY-RAILROADS

| | SHORTAGE | | THEFT | | DAMAGE | | TOTAL | |
|---|---|---|---|---|---|---|---|---|
| COMMODITY GROUPING | VALUE | % OF | VALUE | % OF | VALUE | % OF | VALUE | % OF TOTAL |
| 1. Food and food products | 12,522,827 | 28.5 | 3,295,481 | 12.6 | 203,849,028 | 45.0 | 219,667,336 | 42.0 |
| 2. Alcoholic beverages | 1,889,409 | 4.3 | 915,411 | 3.5 | 3,623,983 | 0.8 | 6,428,803 | 1.2 |
| 3. Tobacco products | 659,096 | 1.5 | 1,909,287 | 7.3 | 1,358,994 | 0.3 | 3,927,377 | .8 |
| 4. Wood Products & furnature | 2,592,445 | 5.9 | 680,020 | 2.6 | 44,846,786 | 9.9 | 48,119,251 | 9.2 |
| 5. Chemicals Petroleun rubber & plastic | 5,800,046 | 13.2 | 2,196,987 | 8.4 | 32,162,847 | 7.1 | 40,159,880 | 7.7 |
| 6. Metal products & hardware | 3,734,878 | 8.5 | 1,987,750 | 7.6 | 22,196,894 | 4.9 | 27,919,522 | 5.3 |
| 7. Machinery (except electrical) | 2,372,746 | 5.4 | 732,329 | 2.8 | 13,136,937 | 2.9 | 16,242,012 | 3.1 |
| 8. Electric machinery including appliances | 2,153,047 | 4.9 | 3,263,326 | 12.5 | 22,196,894 | 4.9 | 27,619,267 | 5.3 |
| 9. Transportation equipment including motor vehicles | 8,304,612 | 18.9 | 10,331,071 | 39.5 | 45,299,784 | 10.0 | 63,935,467 | 12.2 |
| 10. Clothing & textiles | -0- | -0- | -0- | -0- | -0- | -0- | -0- | -0- |
| 11. Jewelry & coins | -0- | -0- | -0- | -0- | -0- | -0- | -0- | -0- |
| 12. Instruments | -0- | -0- | -0- | -0- | -0- | -0- | -0- | -0- |
| 13. Medicines, drugs & cosmetics | -0- | -0- | -0- | -0- | -0- | -0- | -0- | -0- |
| 14. Others | 3,910,637 | 8.9 | 836,948 | 3.2 | 63,419,698 | 14.0 | 68,167,283 | 13.0 |
| Total | 43,939,744 | 100 | 26,154,610 | 100 | 452,997,840 | 100 | 523,092,195 | 100 |
| % of Total Loss | 8.4 | | 5.0 | | 86.6 | | 100 | |

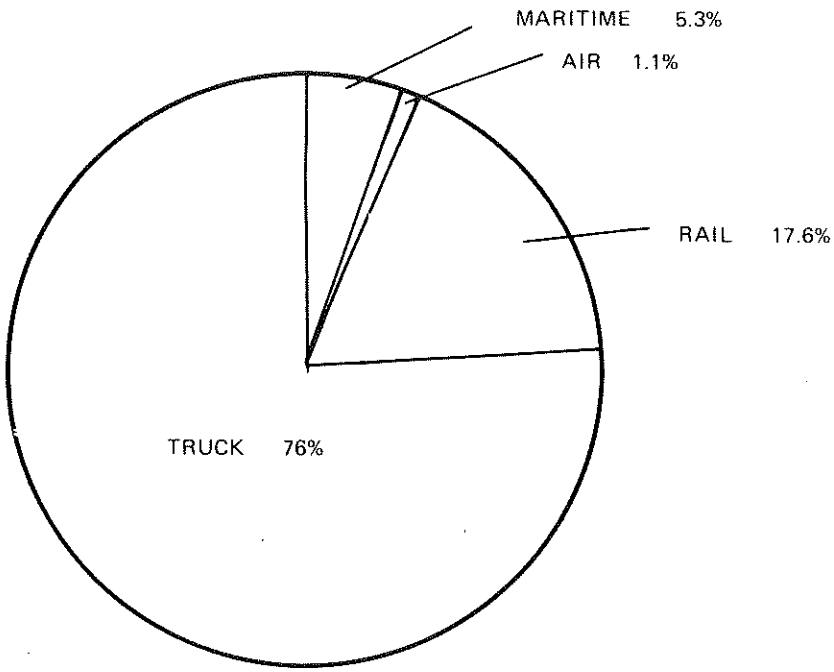
Source: Braddock, Dunn and McDonald. DOT P 5200.3, 1972.




| | | |
|---|---|---|
| AIR | .7 B | 1.1% |
| TRUCK | 43.9 B | 70.8% |
| RAIL | 12.3 B | 19.8% |
| MARITIME: (US & FOREIGN FLAG) | 5.1 B | 8.3% |
| | 62.0 B | 100% |

Figure 1. Freight Revenue by Mode

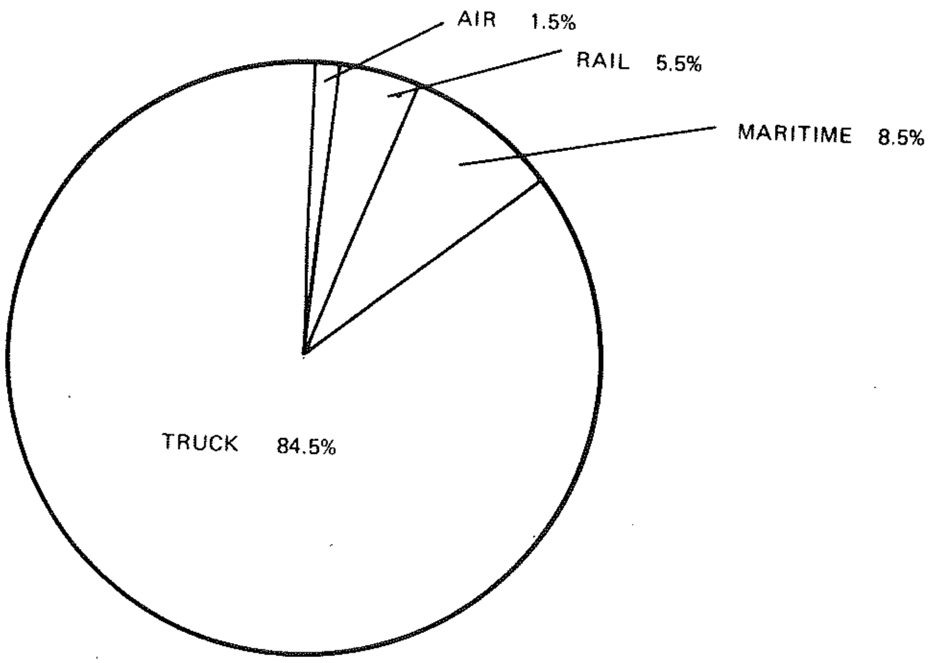
Source: Braddock, Dunn and McDonald DOT P 5200.3, 1972




| | REVENUE | | LOSS | | CARRIER LOSS Amt. | CARRIER LOSS Cost Ratio (Loss÷Revenue) | S/C LOSS Amt. | S/C LOSS Cost Ratio (Loss÷Revenue [freight charges]) |
|---|---|---|---|---|---|---|---|---|
| AIR | .7B | 1.1% | 28.8M | 1.1% | 15.5M | 2.2% | 13.2M | 1.9% |
| TRUCK | 43.9B | 70.8% | 2011.4M | 76% | 1401.2M | 3.2% | 611.2M | 1.39% |
| RAIL | 12.3B | 19.8% | 465.6M | 17.6% | 381.6M | 3.1% | 84.0M | 0.7% |
| MARITIME | 5.1B | 8.3% | 141.2M | 5.3% | 101.2M | 2.0% | 40.0M | 0.8% |
| Total | 62.0B | 100% | 2647.0M | 100% | 1899.5M | 3.06% (Industry average) | 748.4M | 1.2% (Industry average) |

Figure 2 Total Loss by Mode

Source: Braddock, Dunn and McDonald DOT P 5200.3, 1972




| | REVENUE | | LOSS | | CARRIER LOSS | | S/C LOSS | |
|---|---|---|---|---|---|---|---|---|
| | | | | | Amt. | Cost Ratio (Loss÷Revenue) | Amt. | Cost Ratio (Loss÷Revenue [freight charges]) |
| AIR | .7B | 1.1% | 15.4M | 1.5% | 8.3M | 1.2% | 7.1M | 1.0% |
| TRUCK | 43.9B | 70.8% | 850.5M | 84.5% | 591.9M | 1.4% | 258.6M | 0.6% |
| RAIL | 12.3B | 19.8% | 54.5M | 5.5% | 44.6M | 0.2%* | 9.9M | 0.03%* |
| MARITIME | 5.1B | 8.3% | 85.5M | 8.5% | 61.3M | 1.2% | 24.2M | 0.47% |
| Total | 62.0B | 100% | 1005.9M | 100% | 683.1M | 1.1% (Industry average) | 294.7M | .47% (Industry average |

* rail theft estimate is low

Figure 3 Theft-Related Loss by Mode

Source: Braddock, Dunn and McDonald. DOT P 5200.3, 1972

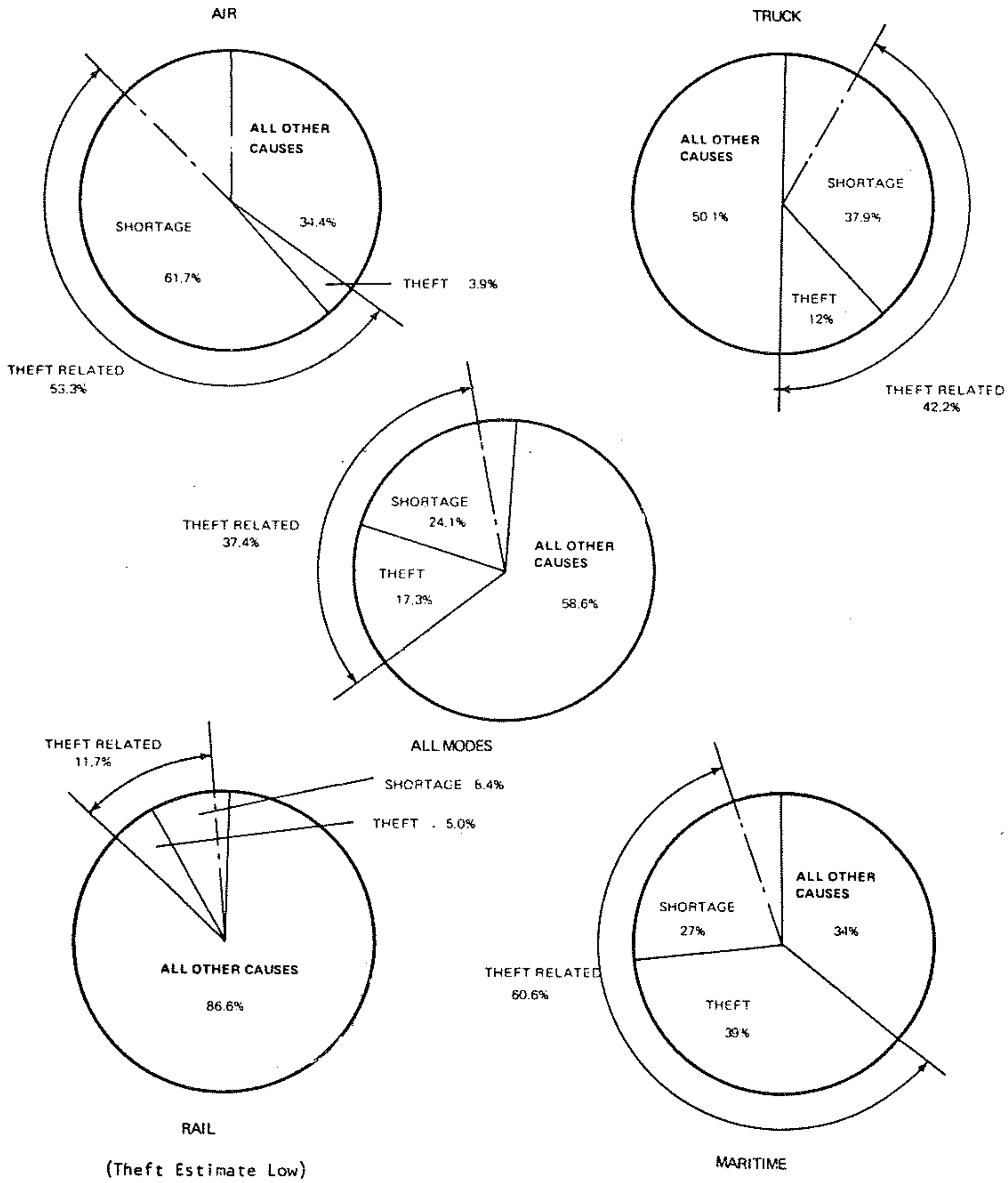



Figure 4 Cause of Loss by Mode as Percentage of Net Claims Paid

Source: Braddock, Dunn and McDonald DOT P 5200.3, 1972.

# ASSOCIATION of AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT

FREIGHT CLAIM DIVISION

Chicago, Illinois

CALENDAR YEAR

**1970**

## FREIGHT LOSS AND DAMAGE

REPORTED BY 78 CARRIERS REPRESENTING APPROXIMATELY 95 PER CENT OF UNITED STATES, CANADIAN AND MEXICAN MILEAGE.

| | CAUSE SYMBOLS | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COMMODITIES | Per Cent of Total L&D | | TOTAL | Loss Entire Package | Loss Other Than Entire Package | Improper Handling—All Damage Not Otherwise Provided For | Defective or Unfit Equipment | Temperature Failures | Delay | Theft | Concealed Damage | Train Accident | Fire, Marine and Catastrophes | Error of Employee |
| 01 * | TOTAL OF 01 | 11.0 | C.L. | $ 24 977 940 | $ 355 517 | $4 056 865 | $6 286 403 | $2 573 521 | $4 833 812 | $3 345 906 | $ 100 624 | $ 4 419 | $ 2 395 773 | $ 799 409 | $ 225 691 |
| 01121 | COTTON, IN BALES | 0.3 | C.L. | 711 054 | 5 938 | 976 | 25 714 | 35 378 | - | - | 790 | - | 58 163 | 583 211 | 884 |
| 0113 | GRAIN | 3.0 | C.L. | 6 962 018 | 16 607 | 2 978 816 | 296 255 | 2 082 076 | - | 131 006 | 20 007 | 160 | 1 325 826 | 16 860 | 94 405 |
| 01144 | SOYBEANS | 0.6 | C.L. | 1 543 365 | 2 660 | 899 372 | 56 395 | 299 749 | - | 23 961 | 3 830 | - | 252 479 | 192 | 4 727 |
| 01195 | POTATOES, OTHER THAN SWEET | 0.7 | C.L. | 1 752 822 | 55 336 | 26 012 | 734 989 | 20 974 | 502 206 | 281 811 | 12 998 | 112 | 54 924 | 45 155 | 18 305 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | 2.0 | C.L. | 4 555 168 | 125 747 | 28 014 | 1 575 413 | 23 441 | 1 591 699 | 887 185 | 26 124 | 313 | 215 804 | 69 029 | 12 419 |
| 013 | ALL FRESH VEGETABLES | 3.4 | C.L. | 7 734 414 | 114 206 | 74 982 | 2 381 475 | 58 964 | 2 706 463 | 1 981 918 | 23 962 | 1 165 | 252 221 | 68 669 | 60 389 |
| 0141 | LIVESTOCK | 0.4 | C.L. | 1 069 984 | 23 628 | - | 955 448 | 2 255 | - | 22 339 | 110 | - | 31 771 | 15 | 34 418 |
| 10 * | METALLIC ORES | 0.8 | C.L. | 1 713 562 | 16 676 | 429 646 | 131 384 | 109 381 | - | 1 460 | 13 925 | - | 988 016 | 4 378 | 18 696 |
| 11 * | COAL | 1.0 | C.L. | 2 095 398 | 34 120 | 549 514 | 115 917 | 287 149 | - | 1 535 | 269 | - | 1 048 435 | 375 | 58 084 |
| 14 * | NONMETALLIC MINERALS | 0.6 | C.L. | 1 158 003 | 13 256 | 165 717 | 578 020 | 145 344 | - | 1 513 | 437 | 159 | 219 563 | 3 435 | 30 559 |
| 20 * | TOTAL OF 20 | 25.1 | C.L. | 57 013 849 | 1 245 218 | 1 563 365 | 36 502 172 | 1 522 072 | 9 005 900 | 523 149 | 724 372 | 66 296 | 5 106 245 | 372 287 | 382 773 |
| 2011 | FRESH MEAT | 4.7 | C.L. | 10 778 569 | 79 953 | 90 700 | 1 141 011 | 133 477 | 7 696 734 | 408 537 | 130 184 | 12 980 | 967 614 | 4 534 | 112 845 |
| 2012 | FROZEN MEAT | 0.2 | C.L. | 457 391 | 51 579 | 6 279 | 19 422 | 727 | 293 251 | 5 339 | 21 413 | 20 | 47 722 | - | 11 639 |
| 2013 | MEAT PRODUCTS | 0.5 | C.L. | 1 029 488 | 78 031 | 22 094 | 670 015 | 276 | 64 252 | 6 476 | 42 743 | 590 | 128 139 | 6 515 | 10 357 |
| 2015 | DRESSED POULTRY | 0.02 | C.L. | 40 902 | 2 918 | 433 | 34 028 | 1 931 | 106 | - | 1 333 | 153 | - | - | - |
| 2016 | FROZEN POULTRY | 0.04 | C.L. | 105 400 | 19 905 | 7 227 | 7 275 | 1 449 | 26 196 | 28 461 | 13 073 | - | 1 814 | - | - |
| 2031 | CANNED OR CURED SEA FOODS | 0.2 | C.L. | 556 411 | 77 120 | 4 953 | 366 354 | 510 | 20 269 | - | 35 140 | 38 | 49 771 | 2 142 | 114 |
| 2032 | CANNED SPECIALTIES | 0.1 | C.L. | 294 816 | 3 827 | 4 502 | 201 816 | 1 247 | - | - | 1 083 | 54 | 82 181 | - | 106 |
| 2033 | CANNED FRUITS OR VEGETABLES | 0.9 | C.L. | 2 163 213 | 49 576 | 7 276 | 1 869 473 | 4 618 | 18 851 | - | 16 119 | 11 616 | 164 639 | 7 264 | 13 781 |
| 2035 | PICKLED FRUITS OR VEGETABLES | 0.2 | C.L. | 350 842 | 6 748 | 3 244 | 282 541 | 240 | - | - | 2 240 | 1 094 | 54 735 | - | - |
| 2036 | FISH, PACKAGED | 0.02 | C.L. | 82 189 | 3 432 | 100 | 22 014 | 70 | 13 788 | - | 322 | - | 42 415 | - | 48 |
| 2037 | FROZEN FRUITS OR VEGETABLES | 0.3 | C.L. | 874 774 | 34 876 | 14 313 | 158 143 | 8 314 | 484 151 | 547 | 27 156 | 356 | 129 634 | - | 17 284 |
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | 0.8 | C.L. | 1 888 818 | 48 530 | 8 874 | 1 611 378 | 6 408 | 756 | 186 | 30 603 | - | 136 600 | 40 379 | 5 104 |
| 204 | GRAIN MILL PRODUCTS | 6.2 | C.L. | 14 102 963 | 95 356 | 478 731 | 11 658 389 | 716 076 | 13 571 | 34 401 | 42 557 | 3 549 | 928 313 | 51 437 | 50 533 |
| 2062 | SUGAR, REFINED | 1.1 | C.L. | 2 437 913 | 15 290 | 3 225 | 2 127 372 | 72 978 | - | - | 7 610 | 1 665 | 204 691 | 4 411 | 1 671 |
| 20821 | BEER | 1.1 | C.L. | 2 494 478 | 67 946 | 18 188 | 2 029 268 | 4 151 | 69 279 | 1 706 | 47 454 | 5 344 | 165 753 | 46 473 | 18 916 |
| 2084 | WINES, BRANDY | [illegible] | C.L. | [illegible] | [illegible] | | | | | | | | | | |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2062 | SUGAR, REFINED | 1.1 | C.L. | 2 437 913 | 15 290 | 3 225 | 2 127 372 | 71 978 | - | - | 7 610 | 1 665 | 204 691 | 4 411 | 1 671 |
| 20821 | BEER | 1.1 | C.L. | 2 494 478 | 67 946 | 18 188 | 2 029 268 | 4 151 | 69 279 | 1 706 | 47 454 | 5 344 | 185 753 | 46 473 | 18 916 |
| 2084 | WINES, BRANDY | 0.3 | C.L. | 723 161 | 19 115 | 5 156 | 622 672 | 278 | 1 996 | - | 19 160 | 659 | 32 856 | 20 826 | 443 |
| 20851 | WHISKEY | 0.8 | C.L. | 1 972 032 | 145 724 | 32 101 | 1 536 110 | 1 613 | 2 261 | - | 73 918 | 8 437 | 165 954 | 4 753 | 1 261 |
| 2086 | SOFT DRINKS | 0.02 | C.L. | 54 738 | 1 763 | 29 | 52 659 | 10 | 20 | - | 4 | 253 | - | - | - |
| 209 | MISC. FOOD PREPARATIONS | 4.8 | C.L. | 11 020 660 | 249 574 | 689 835 | 8 288 181 | 344 213 | 105 242 | 8 265 | 118 867 | 649 | 1 091 274 | 85 802 | 38 758 |
| • 21 | TOBACCO PRODUCTS | 0.7 | C.L. | 1 626 798 | 53 690 | 45 333 | 999 757 | 98 357 | - | - | 288 433 | 3 131 | 137 657 | - | 440 |
| • 24 | TOTAL OF 24 | 3.9 | C.L. | 8 874 055 | 100 162 | 77 586 | 6 069 103 | 100 015 | - | 13 356 | 24 198 | 42 693 | 1 932 852 | 447 358 | 66 732 |
| 2432 | PLYWOOD OR VENEER | 1.4 | C.L. | 3 245 309 | 14 664 | 2 631 | 2 430 456 | 24 816 | - | 1 416 | 1 335 | 295 | 656 091 | 110 087 | 3 518 |
| • 25 | FURNITURE AND FIXTURES | 2.1 | C.L. | 4 898 507 | 90 717 | 18 326 | 3 427 299 | 35 038 | - | 116 | 45 246 | 823 929 | 389 243 | 68 593 | - |
| • 26 | TOTAL OF 26 | 5.7 | C.L. | 13 085 591 | 79 904 | 28 503 | 10 027 810 | 149 384 | - | 4 653 | 31 790 | 20 339 | 2 352 319 | 327 877 | 63 012 |
| 26211 | NEWSPRINT | 1.2 | C.L. | 2 845 446 | 1 367 | 2 878 | 2 630 965 | 19 356 | - | - | 178 | 2 294 | 151 063 | 37 023 | 322 |
| • 28 | CHEMICALS OR ALLIED PRODUCTS | 5.0 | C.L. | 11 849 394 | 210 118 | 268 247 | 7 280 746 | 370 724 | 19 102 | 10 903 | 89 182 | 8 126 | 3 325 987 | 113 608 | 122 651 |
| • 29 | PETROLEUM OR COAL PRODUCTS | 0.9 | C.L. | 2 142 497 | 22 685 | 65 644 | 1 596 816 | 22 012 | - | 519 | 9 242 | 4 037 | 404 125 | 651 | 16 766 |
| • 30 | RUBBER AND MISC. PLASTICS | 0.7 | C.L. | 1 574 940 | 244 297 | 75 130 | 556 928 | 9 462 | 389 | - | 233 992 | 4 888 | 328 917 | 120 937 | - |
| • 32 | TOTAL OF 32 | 3.2 | C.L. | 7 316 535 | 53 236 | 118 490 | 5 885 724 | 161 121 | - | - | 15 426 | 344 286 | 834 753 | 48 024 | 50 475 |
| 321 | FLAT GLASS | 0.7 | C.L. | 1 606 095 | 1 330 | 1 845 | 1 416 018 | 13 741 | - | - | 69 | 67 668 | 102 325 | 2 964 | 135 |
| 322 | GLASSWARE | 0.2 | C.L. | 549 906 | 10 423 | 2 797 | 413 257 | 12 913 | - | - | 8 102 | 22 164 | 63 013 | 15 271 | 1 966 |
| 32511 | BRICK | 0.4 | C.L. | 903 280 | 3 545 | 17 617 | 858 242 | 27 | - | - | 208 | 2 180 | 21 366 | - | 95 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | 0.1 | C.L. | 199 524 | 220 | 694 | 171 453 | 1 301 | - | - | 398 | 1 769 | 14 906 | 7 815 | 968 |
| • 33 | PRIMARY METAL PRODUCTS | 4.0 | C.L. | 9 136 349 | 252 896 | 214 141 | 6 125 129 | 199 950 | - | - | 281 469 | 18 619 | 1 861 914 | 95 847 | 86 384 |
| • 34 | FABRICATED METAL PRODUCTS | 1.8 | C.L. | 4 186 632 | 80 274 | 18 582 | 2 932 986 | 38 801 | - | 1 026 | 19 138 | 74 922 | 946 125 | 55 774 | 19 004 |
| • 35 | MACHINERY, EXCEPT ELECTRICAL | 2.6 | C.L. | 5 932 365 | 264 177 | 93 522 | 3 431 751 | 15 458 | - | 5 729 | 112 092 | 246 225 | 1 682 735 | 148 267 | 30 402 |
| • 36 | TOTAL OF 36 | 4.3 | C.L. | 9 844 961 | 284 261 | 42 742 | 5 645 649 | 26 335 | - | - | 497 039 | 1 911 689 | 1 323 465 | 67 425 | 46 356 |
| 363 | HOUSEHOLD APPLIANCES | 2.7 | C.L. | 6 324 750 | 55 859 | 12 428 | 3 981 488 | 7 809 | - | - | 84 255 | 1 727 431 | 415 793 | 31 565 | 8 122 |
| • 37 | TOTAL OF 37 | 15.5 | C.L. | 35 492 060 | 171 758 | 1 096 140 | 25 787 234 | 12 618 | - | 627 | 1 564 969 | 48 889 | 6 600 593 | 168 130 | 40 802 |
| 3711 | MOTOR VEHICLES | 13.3 | C.L. | 30 491 357 | 138 959 | 1 077 416 | 23 162 597 | 8 278 | - | 624 | 1 539 167 | 38 281 | 4 436 465 | 50 592 | 38 978 |
| 3714 | MOTOR VEHICLE PARTS | 1.5 | C.L. | 3 565 082 | 11 312 | 6 553 | 2 014 649 | 618 | - | - | 9 684 | 4 469 | 1 423 564 | 94 016 | 217 |
| • 44 | FREIGHT FORWARDER TRAFFIC | 2.8 | C.L. | 6 356 104 | 418 662 | 54 965 | 3 108 002 | 22 773 | 14 252 | 1 134 | 378 434 | 810 959 | 1 442 886 | 92 714 | 11 318 |
| • 45 | SHIPPER ASSOCIATION TRAFFIC | 1.9 | C.L. | 4 402 627 | 664 007 | 72 458 | 1 639 150 | 31 608 | 11 758 | 124 | 200 030 | 643 935 | 1 048 034 | 78 933 | 12 590 |
| • | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | 5.2 | C.L. | 11 970 619 | 1 022 950 | 564 512 | 6 057 654 | 151 803 | 178 128 | 25 368 | 820 513 | 206 356 | 2 411 387 | 320 406 | 211 544 |
| • 47 | L.C.L. | 1.2 | | 2 667 603 | 1 255 256 | 64 523 | 953 324 | 4 234 | 6 104 | 12 310 | 82 346 | 256 192 | 1 744 | 10 | 31 560 |
| | TOTAL (All 2-digit Items, except 47-L.C.L.) | 98.8 | C.L. | 225 648 786 | 5 683 581 | 9 621 735 | 134 185 634 | 6 082 929 | 14 093 341 | 3 937 118 | 5 450 820 | 4 983 897 | 36 781 024 | 3 334 428 | 1 494 279 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit Items) | 100.0 | | 228 316 389 | 6 938 837 | 9 686 258 | 135 138 958 | 6 087 163 | 14 099 445 | 3 949 428 | 5 533 166 | 5 240 089 | 36 782 768 | 3 334 438 | 1 525 839 |
| | PER CENT | | | 100.0 | 3.1 | 4.3 | 59.2 | 2.7 | 6.2 | 1.8 | 2.4 | 2.2 | 16.1 | 1.4 | 0.6 |
| | **CAUSE SYMBOLS** | | | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |

Figure 5

# ASSOCIATION of AMERICAN RAILROADS

OPERATIONS AND MAINTENANCE DEPARTMENT

## FREIGHT CLAIM DIVISION

Chicago, Illinois

## FREIGHT LOSS AND DAMAGE

CALENDAR YEAR

# 1970

REPORTED BY 78 CARRIERS REPRESENTING APPROXIMATELY 95 PER CENT OF UNITED STATES, CANADIAN AND MEXICAN MILEAGE.

| CAUSE SYMBOLS | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COMMODITIES | Per Cent of Total L&D | | TOTAL | Loss Entire Package | Loss Other Than Entire Package | Improper Handling—All Damage Not Otherwise Provided For | Defective or Unfit Equipment | Temperature Failures | Delay | Theft | Concealed Damage | Train Accident | Fire, Marine and Catastrophes | Error of Employee |
| 01 | TOTAL OF 01 | 11.0 | C.L. | $ 24 977 940 | $ 355 517 | $4 056 865 | $5 286 403 | $2 573 521 | $4 833 812 | $3 345 906 | $ 100 624 | $ 4 419 | $ 2 395 773 | $ 799 409 | $ 225 691 |
| 01121 | COTTON, IN BALES | 0.3 | C.L. | 711 054 | 5 938 | 976 | 25 714 | 35 378 | - | - | 790 | - | 58 163 | 583 211 | 884 |
| 0113 | GRAIN | 3.0 | C.L. | 6 962 018 | 16 607 | 2 978 816 | 296 255 | 2 082 076 | - | 131 006 | 20 007 | 160 | 1 325 826 | 16 860 | 94 405 |
| 01144 | SOYBEANS | 0.6 | C.L. | 1 543 365 | 2 660 | 899 372 | 56 395 | 299 749 | - | 23 961 | 3 830 | - | 252 479 | 192 | 4 727 |
| 01195 | POTATOES, OTHER THAN SWEET | 0.7 | C.L. | 1 752 822 | 55 336 | 26 012 | 734 989 | 20 974 | 502 206 | 281 611 | 12 998 | 112 | 54 924 | 45 155 | 18 305 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | 2.0 | C.L. | 4 555 188 | 125 747 | 28 014 | 1 575 413 | 23 441 | 1 591 699 | 887 185 | 26 124 | 313 | 215 804 | 69 029 | 12 419 |
| 013 | ALL FRESH VEGETABLES | 3.4 | C.L. | 7 734 414 | 114 206 | 74 982 | 2 381 475 | 58 964 | 2 706 463 | 1 981 918 | 33 962 | 1 165 | 252 221 | 68 669 | 60 389 |
| 0141 | LIVESTOCK | 0.4 | C.L. | 1 069 984 | 23 628 | - | 955 448 | 2 255 | - | 22 339 | 110 | - | 31 771 | 15 | 34 418 |
| 10 | METALLIC ORES | 0.8 | C.L. | 1 713 562 | 16 676 | 429 646 | 131 384 | 109 381 | - | 1 460 | 13 925 | - | 983 016 | 4 378 | 18 696 |
| 11 | COAL | 1.0 | C.L. | 2 095 398 | 34 120 | 549 514 | 115 917 | 287 149 | - | 1 535 | 269 | - | 1 048 435 | 375 | 58 084 |
| 14 | NONMETALLIC MINERALS | 0.6 | C.L. | 1 158 003 | 13 256 | 165 717 | 578 020 | 145 344 | - | 1 513 | 437 | 159 | 219 563 | 3 435 | 30 559 |
| 20 | TOTAL OF 20 | 25.1 | C.L. | 57 013 849 | 1 245 218 | 1 563 365 | 35 502 172 | 1 522 072 | 9 005 900 | 523 149 | 724 372 | 66 296 | 5 106 245 | 372 287 | 382 773 |
| 2011 | FRESH MEAT | 4.7 | C.L. | 10 778 569 | 79 953 | 90 700 | 1 141 011 | 133 477 | 7 696 734 | 408 537 | 130 184 | 12 980 | 967 614 | 4 534 | 112 845 |
| 2012 | FROZEN MEAT | 0.2 | C.L. | 457 391 | 51 579 | 6 279 | 19 422 | 727 | 293 251 | 5 339 | 21 413 | 20 | 47 722 | - | 11 639 |
| 2013 | MEAT PRODUCTS | 0.5 | C.L. | 1 029 488 | 78 031 | 22 094 | 670 015 | 276 | 64 252 | 6 476 | 42 743 | 590 | 128 139 | 6 515 | 10 357 |
| 2015 | DRESSED POULTRY | 0.02 | C.L. | 40 902 | 2 918 | 433 | 34 028 | 1 931 | 106 | - | 1 333 | 153 | - | - | - |
| 2016 | FROZEN POULTRY | 0.04 | C.L. | 105 400 | 19 905 | 7 227 | 7 275 | 1 449 | 26 196 | 28 461 | 13 073 | - | 1 814 | - | - |
| 2031 | CANNED OR CURED SEA FOODS | 0.2 | C.L. | 556 411 | 77 120 | 4 953 | 366 354 | 510 | 20 269 | - | 35 140 | 38 | 49 771 | 2 142 | 114 |
| 2032 | CANNED SPECIALTIES | 0.1 | C.L. | 294 816 | 3 827 | 4 502 | 201 816 | 1 247 | - | - | 1 083 | 54 | 82 181 | - | 106 |
| 2033 | CANNED FRUITS OR VEGETABLES | 0.9 | C.L. | 2 163 213 | 49 576 | 7 276 | 1 869 473 | 4 618 | 18 851 | - | 16 119 | 11 616 | 164 639 | 7 264 | 13 781 |
| 2035 | PICKLED FRUITS OR VEGETABLES | 0.2 | C.L. | 350 842 | 6 748 | 3 244 | 282 541 | 240 | - | - | 2 240 | 1 094 | 54 735 | - | - |
| 2036 | FISH, PACKAGED | 0.02 | C.L. | 82 189 | 3 432 | 100 | 22 614 | 70 | 13 788 | - | 322 | - | 42 415 | - | 48 |
| 2037 | FROZEN FRUITS OR VEGETABLES | 0.3 | C.L. | 874 774 | 34 876 | 14 313 | 158 143 | 8 314 | 484 151 | 547 | 27 156 | [illegible] | [illegible] | | [illegible] |

| | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | 0.8 | C.L. | 1 888 818 | 48 530 | 8 874 | 1 611 378 | 6 408 | 756 | 186 | 30 603 | - | 136 800 | 40 379 | 5 104 |
| 204 | GRAIN MILL PRODUCTS | 6.2 | C.L. | 14 102 963 | 95 356 | 478 731 | 11 658 389 | 716 076 | 13 571 | 34 401 | 42 557 | 3 549 | 928 313 | 51 437 | 80 533 |
| 2062 | SUGAR, REFINED | 1.1 | C.L. | 2 437 913 | 15 290 | 3 225 | 2 127 372 | 71 978 | - | - | 7 610 | 1 665 | 204 691 | 4 411 | 1 671 |
| 20821 | BEER | 1.1 | C.L. | 2 494 478 | 67 946 | 18 188 | 2 029 268 | 4 151 | 69 279 | 1 706 | 47 454 | 5 344 | 185 753 | 46 473 | 18 916 |
| 2084 | WINES, BRANDY | 0.3 | C.L. | 723 161 | 19 115 | 5 156 | 622 672 | 278 | 1 996 | - | 19 160 | 659 | 32 856 | 20 826 | 443 |
| 20851 | WHISKEY | 0.8 | C.L. | 1 972 032 | 145 724 | 32 101 | 1 536 110 | 1 613 | 2 261 | - | 73 818 | 8 437 | 165 954 | 4 753 | 1 261 |
| 2086 | SOFT DRINKS | 0.02 | C.L. | 54 738 | 1 763 | 29 | 52 659 | 10 | 20 | - | 4 | 253 | - | - | - |
| 209 | MISC. FOOD PREPARATIONS | 4.8 | C.L. | 11 020 660 | 249 574 | 689 835 | 8 288 181 | 344 213 | 105 242 | 8 265 | 118 867 | 649 | 1 091 274 | 85 802 | 38 758 |
| 21 | TOBACCO PRODUCTS | 0.7 | C.L. | 1 626 798 | 53 690 | 45 333 | 999 757 | 98 357 | - | - | 288 433 | 3 131 | 137 657 | - | 440 |
| 24 | TOTAL OF 24 | 3.9 | C.L. | 8 874 055 | 100 162 | 77 586 | 6 069 103 | 100 015 | - | 13 356 | 24 198 | 42 693 | 1 932 852 | 447 358 | 66 732 |
| 2432 | PLYWOOD OR VENEER | 1.4 | C.L. | 3 215 309 | 14 664 | 2 631 | 2 430 456 | 24 816 | - | 1 416 | 1 335 | 295 | 656 091 | 110 067 | 3 518 |
| 25 | FURNITURE AND FIXTURES | 2.1 | C.L. | 4 898 507 | 90 717 | 18 326 | 3 427 299 | 35 038 | - | 116 | 45 246 | 823 929 | 389 243 | 68 593 | - |
| 26 | TOTAL OF 26 | 5.7 | C.L. | 13 085 591 | 79 904 | 28 503 | 10 027 810 | 149 384 | - | 4 653 | 31 790 | 20 339 | 2 352 312 | 327 877 | 63 012 |
| 26211 | NEWSPRINT | 1.2 | C.L. | 2 845 446 | 1 367 | 2 878 | 2 630 965 | 19 356 | - | - | 178 | 2 294 | 151 063 | 37 023 | 322 |
| 28 | CHEMICALS OR ALLIED PRODUCTS | 5.0 | C.L. | 11 849 394 | 210 118 | 268 247 | 7 280 746 | 370 724 | 49 102 | 10 903 | 89 182 | 8 126 | 3 325 987 | 113 608 | 122 651 |
| 29 | PETROLEUM OR COAL PRODUCTS | 0.9 | C.L. | 2 142 497 | 22 685 | 65 644 | 1 596 816 | 22 012 | - | 519 | 9 242 | 4 037 | 404 125 | 651 | 16 766 |
| 30 | RUBBER AND MISC. PLASTICS | 0.7 | C.L. | 1 574 940 | 244 297 | 75 132 | 556 928 | 9 462 | 389 | - | 233 992 | 4 888 | 328 917 | 120 937 | - |
| 32 | TOTAL OF 32 | 3.2 | C.L. | 7 316 535 | 53 236 | 118 490 | 5 885 724 | 161 121 | - | - | 15 426 | 144 286 | 834 753 | 48 024 | 50 475 |
| 321 | FLAT GLASS | 0.7 | C.L. | 1 606 095 | 1 330 | 1 845 | 1 416 018 | 13 741 | - | - | 69 | 67 668 | 102 325 | 2 964 | 135 |
| 322 | GLASSWARE | 0.2 | C.L. | 549 906 | 10 423 | 2 797 | 413 257 | 12 913 | - | - | 8 102 | 22 164 | 63 013 | 15 271 | 1 966 |
| 32511 | BRICK | 0.4 | C.L. | 903 280 | 3 545 | 17 617 | 858 242 | 27 | - | - | 208 | 2 180 | 21 366 | - | 95 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | 0.1 | C.L. | 199 524 | 220 | 694 | 171 453 | 1 301 | - | - | 398 | 1 769 | 14 906 | 7 815 | 968 |
| 33 | PRIMARY METAL PRODUCTS | 4.0 | C.L. | 9 136 349 | 252 896 | 214 141 | 6 125 129 | 199 950 | - | - | 281 459 | 18 619 | 1 861 914 | 95 847 | 86 384 |
| 34 | FABRICATED METAL PRODUCTS | 1.8 | C.L. | 4 186 632 | 80 274 | 18 582 | 2 932 986 | 38 803 | - | 1 026 | 19 138 | 74 922 | 946 125 | 55 774 | 19 004 |
| 35 | MACHINERY, EXCEPT ELECTRICAL | 2.6 | C.L. | 5 932 365 | 264 177 | 95 529 | 3 431 751 | 15 458 | - | 5 729 | 112 092 | 146 225 | 1 682 735 | 148 267 | 30 402 |
| 36 | TOTAL OF 36 | 4.3 | C.L. | 9 844 961 | 284 261 | 42 742 | 5 645 649 | 26 335 | - | - | 497 039 | 1 911 689 | 1 323 465 | 67 425 | 46 356 |
| 363 | HOUSEHOLD APPLIANCES | 2.7 | C.L. | 6 324 750 | 55 859 | 12 428 | 3 981 488 | 7 809 | - | - | 84 255 | 1 727 431 | 415 793 | 31 565 | 8 122 |
| 37 | TOTAL OF 37 | 15.5 | C.L. | 35 492 060 | 171 758 | 1 096 440 | 25 787 234 | 12 618 | - | 627 | 1 564 969 | 48 889 | 6 600 593 | 168 130 | 40 802 |
| 3711 | MOTOR VEHICLES | 13.3 | C.L. | 30 491 357 | 138 959 | 1 077 416 | 23 162 597 | 8 278 | - | 624 | 1 539 167 | 38 281 | 4 436 465 | 50 592 | 38 978 |
| 3714 | MOTOR VEHICLE PARTS | 1.5 | C.L. | 3 565 082 | 11 312 | 6 553 | 2 014 649 | 618 | - | - | 9 684 | 4 469 | 1 423 564 | 94 016 | 217 |
| 44 | FREIGHT FORWARDER TRAFFIC | 2.8 | C.L. | 6 356 104 | 418 662 | 54 965 | 3 108 002 | 22 773 | 14 252 | 1 134 | 378 434 | 810 959 | 1 442 886 | 92 734 | 11 318 |
| 45 | SHIPPER ASSOCIATION TRAFFIC | 1.9 | C.L. | 4 402 627 | 664 007 | 72 458 | 1 639 150 | 31 608 | 11 758 | 124 | 200 030 | 643 935 | 1 048 034 | 78 933 | 12 590 |
| | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | 5.2 | C.L. | 11 970 619 | 1 022 950 | 564 512 | 6 057 654 | 151 803 | 178 128 | 25 368 | 820 513 | 206 356 | 2 411 387 | 320 406 | 211 544 |
| 47 | L.C.L. | 1.2 | | 2 667 603 | 1 255 256 | 64 523 | 953 324 | 4 234 | 6 104 | 12 310 | 82 346 | 256 192 | 1 744 | 10 | 31 560 |
| | TOTAL (All 2-digit Items, except 47-L.C.L.) | 98.8 | C.L. | 225 648 786 | 5 683 581 | 9 621 735 | 134 185 634 | 6 082 929 | 14 093 341 | 3 937 118 | 5 450 820 | 4 983 897 | 36 781 024 | 3 334 428 | 1 494 279 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit Items) | 100.0 | | 228 316 389 | 6 938 837 | 9 686 258 | 135 138 958 | 6 087 163 | 14 099 445 | 3 949 428 | 5 533 166 | 5 240 089 | 36 782 768 | 3 334 438 | 1 525 839 |
| | PER CENT | | | 100.0 | 3.1 | 4.3 | 59.2 | 2.7 | 6.2 | 1.8 | 2.4 | 2.2 | 16.1 | 1.4 | 0.6 |
| | CAUSE SYMBOLS | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

COMMODITY COMPARISONS

1970 vs. 1969

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 01 * | TOTAL OF 01 | +20.8 | C.L. | $ 24 977 940 | 11.0 | 9.9 | $ 20 676 889 |
| 01121 | COTTON, IN BALES | - 5.6 | C.L. | 711 054 | 0.3 | 0.4 | 753 029 |
| 0113 | GRAIN | +19.3 | C.L. | 6 962 018 | 3.0 | 2.8 | 5 834 915 |
| 01144 | SOYBEANS | +37.2 | C.L. | 1 543 365 | 0.6 | 0.5 | 1 124 868 |
| 01195 | POTATOES, OTHER THAN SWEET | +10.4 | C.L. | 1 752 822 | 0.7 | 0.8 | 1 587 513 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | +13.6 | C.L. | 4 555 188 | 2.0 | 1.9 | 4 009 382 |
| 013 | ALL FRESH VEGETABLES | +32.0 | C.L. | 7 734 414 | 3.4 | 2.8 | 5 858 694 |
| 0141 | LIVESTOCK | + 6.2 | C.L. | 1 069 984 | 0.4 | 0.5 | 1 007 325 |
| 10 * | METALLIC ORES | +38.2 | C.L. | 1 713 562 | 0.8 | 0.6 | 1 239 548 |
| 11 * | COAL | - 8.4 | C.L. | 2 095 398 | 1.0 | 1.1 | 2 287 466 |
| 14 * | NONMETALLIC MINERALS | - 1.4 | C.L. | 1 158 003 | 0.6 | 0.6 | 1 171 365 |
| 20 * | TOTAL OF 20 | + 5.8 | C.L. | 57 013 849 | 25.1 | 25.6 | 53 880 283 |
| 2011 | FRESH MEAT | +29.9 | C.L. | 10 778 569 | 4.7 | 3.9 | 8 295 469 |
| 2012 | FROZEN MEAT | +14.8 | C.L. | 457 391 | 0.2 | 0.2 | 398 128 |
| 2013 | MEAT PRODUCTS | +11.9 | C.L. | 1 029 488 | 0.5 | 0.4 | 919 935 |
| 2015 | DRESSED POULTRY | -18.7 | C.L. | 40 902 | 0.02 | 0.02 | 50 261 |
| 2016 | FROZEN POULTRY | -25.4 | C.L. | 105 400 | 0.04 | 0.06 | 141 252 |
| 2031 | CANNED OR CURED SEA FOODS | + 0.1 | C.L. | 556 411 | 0.2 | 0.3 | 556 292 |
| 2032 | CANNED SPECIALTIES | - 7.5 | C.L. | 294 816 | 0.1 | 0.2 | 318 453 |
| 2033 | CANNED FRUITS OR VEGETABLES | -13.0 | C.L. | 2 163 213 | 0.9 | 1.2 | 2 484 581 |
| 2035 | PICKLED FRUITS OR VEGETABLES | -10.8 | C.L. | 350 842 | 0.2 | 0.2 | 393 049 |
| 2036 | FISH, PACKAGED | +71.7 | C.L. | 82 189 | 0.02 | 0.02 | 47 857 |
| 2037 | FROZEN FRUITS OR VEGETABLES | - 8.6 | C.L. | 874 774 | 0.3 | 0.5 | 957 053 |
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | - 5.5 | C.L. | 1 888 818 | 0.8 | 1.0 | 1 997 217 |
| 204 | GRAIN MILL PRODUCTS | + 1.1 | C.L. | 14 102 963 | 6.2 | 6.6 | 13 941 439 |
| 2062 | SUGAR, REFINED | -25.8 | C.L. | 2 437 913 | 1.1 | 1.6 | 3 282 976 |
| 20821 | BEER | + 4.7 | C.L. | 2 494 478 | 1.1 | 1.1 | 2 381 484 |
| 2084 | WINES, BRANDY | +33.1 | C.L. | 723 161 | 0.3 | 0.3 | 542 978 |
| 20851 | WHISKEY | - 9.4 | C.L. | 1 972 032 | 0.8 | 1.0 | 2 176 526 |
| 2086 | SOFT DRINKS | - 6.4 | C.L. | 54 738 | 0.02 | 0.03 | 58 345 |
| 209 | MISC. FOOD PREPARATIONS | +13.0 | C.L. | 11 020 660 | 4.8 | 4.6 | 9 747 053 |
| 21 * | TOBACCO PRODUCTS | - 6.1 | C.L. | 1 626 798 | 0.7 | 0.8 | 1 692 544 |

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 24 * | TOTAL OF 24 | -16.1 | C.L. | 8 874 055 | 3.9 | 5.0 | 10 574 623 |
| 2432 | PLYWOOD OR VENEER | -27.4 | C.L. | 3 245 309 | 1.4 | 2.1 | 4 467 406 |
| 25 * | FURNITURE AND FIXTURES | -15.0 | C.L. | 4 898 507 | 2.1 | 2.7 | 5 754 238 |
| 26 * | TOTAL OF 26 | + 5.5 | C.L. | 13 085 591 | 5.7 | 5.9 | 12 395 308 |
| 26211 | NEWSPRINT | -10.4 | C.L. | 2 845 446 | 1.2 | 1.5 | 3 173 808 |
| 28 * | CHEMICALS OR ALLIED PRODUCTS | + 9.2 | C.L. | 11 849 394 | 5.0 | 5.2 | 10 846 301 |
| 29 * | PETROLEUM OR COAL PRODUCTS | +16.7 | C.L. | 2 142 497 | 0.9 | 0.9 | 1 835 629 |
| 30 * | RUBBER AND MISC. PLASTICS | +57.4 | C.L. | 1 574 940 | 0.7 | 0.5 | 1 000 270 |
| 32 * | TOTAL OF 32 | + 1.6 | C.L. | 7 316 535 | 3.2 | 3.4 | 7 197 643 |
| 321 | FLAT GLASS | - 1.1 | C.L. | 1 606 095 | 0.7 | 0.8 | 1 623 576 |
| 322 | GLASSWARE | - 1.0 | C.L. | 549 906 | 0.2 | 0.3 | 554 995 |
| 32511 | BRICK | -11.1 | C.L. | 903 280 | 0.4 | 0.5 | 1 015 957 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | -12.0 | C.L. | 199 524 | 0.1 | 0.1 | 226 775 |
| 33 * | PRIMARY METAL PRODUCTS | + 7.0 | C.L. | 9 136 349 | 4.0 | 4.1 | 8 537 485 |
| 34 * | FABRICATED METAL PRODUCTS | - 2.1 | C.L. | 4 186 632 | 1.8 | 2.0 | 4 275 045 |
| 35 * | MACHINERY, EXCEPT ELECTRICAL | - 2.2 | C.L. | 5 932 365 | 2.6 | 2.9 | 6 065 280 |
| 36 * | TOTAL OF 36 | -24.5 | C.L. | 9 844 961 | 4.3 | 6.2 | 13 025 901 |
| 363 | HOUSEHOLD APPLIANCES | -27.1 | C.L. | 6 324 750 | 2.7 | 4.1 | 8 668 179 |
| 37 * | TOTAL OF 37 | +38.1 | C.L. | 35 492 060 | 15.5 | 12.2 | 25 689 427 |
| 3711 | MOTOR VEHICLES | +39.7 | C.L. | 30 491 357 | 13.3 | 10.3 | 21 814 900 |
| 3714 | MOTOR VEHICLE PARTS | +18.3 | C.L. | 3 565 082 | 1.5 | 1.4 | 3 006 876 |
| 44 * | FREIGHT FORWARDER TRAFFIC | -17.1 | C.L. | 6 356 104 | 2.8 | 3.6 | 7 660 908 |
| 45 * | SHIPPER ASSOCIATION TRAFFIC | +11.9 | C.L. | 4 402 627 | 1.9 | 1.9 | 3 933 687 |
| * | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | +41.8 | C.L. | 11 970 619 | 5.2 | 4.0 | 8 440 000 |
| 47 * | L.C.L. | +46.5 | | 2 667 603 | 1.2 | 0.9 | 1 920 323 |
| | TOTAL (All 2-digit items, except 47-L.C.L.) | + 8.3 | C.L. | 225 648 786 | 98.8 | 99.1 | 208 179 840 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit items) | + 8.7 | | 228 316 389 | 100.0 | 100.0 | 210 100 163 |

*Use 2-digit items only to obtain "TOTAL C.L." and "SUMMARY-C.L. and L.C.L. Combined", at bottom of statement.

# ASSOCIATION of AMERICAN RAILROADS

## OPERATIONS AND MAINTENANCE DEPARTMENT

## FREIGHT CLAIM DIVISION

### Chicago, Illinois

CALENDAR YEAR

**1970**

## FREIGHT LOSS AND DAMAGE

REPORTED BY 78 CARRIERS REPRESENTING APPROXIMATELY 95 PER CENT OF UNITED STATES, CANADIAN AND MEXICAN MILEAGE.

| | CAUSE SYMBOLS | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COMMODITIES | Per Cent of Total L&D | | TOTAL | Loss Entire Package | Loss Other Than Entire Package | Improper Handling—All Damage Not Otherwise Provided For | Defective or Unfit Equipment | Temperature Failures | Delay | Theft | Concealed Damage | Train Accident | Fire, Marine and Catastrophes | Error of Employee |
| 01 • | TOTAL OF 01 | 11.0 | C.L. | $ 24 977 940 | $ 355 517 | $4 056 865 | $6 286 403 | $2 573 521 | $4 833 812 | $3 345 906 | $ 100 624 | $ 4 419 | $ 2 395 773 | $ 799 402 | $ 225 691 |
| 01121 | COTTON, IN BALES | 0.3 | C.L. | 711 054 | 5 938 | 976 | 25 714 | 35 378 | - | - | 790 | - | 58 163 | 583 271 | 884 |
| 0113 | GRAIN | 3.0 | C.L. | 6 962 018 | 16 607 | 2 978 816 | 296 255 | 2 082 076 | - | 131 006 | 20 007 | 160 | 1 325 826 | 16 860 | 94 405 |
| 01144 | SOYBEANS | 0.6 | C.L. | 1 543 365 | 2 660 | 899 372 | 56 395 | 299 749 | - | 23 961 | 3 830 | - | 252 479 | 192 | 4 727 |
| 01195 | POTATOES, OTHER THAN SWEET | 0.7 | C.L. | 1 752 822 | 55 336 | 26 012 | 734 989 | 20 974 | 502 206 | 281 811 | 12 998 | 112 | 54 924 | 45 155 | 18 305 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | 2.0 | C.L. | 4 555 188 | 125 747 | 28 014 | 1 575 413 | 23 441 | 1 591 699 | 887 185 | 26 124 | 313 | 215 804 | 69 029 | 12 419 |
| 013 | ALL FRESH VEGETABLES | 3.4 | C.L. | 7 734 414 | 114 206 | 74 982 | 2 381 475 | 58 964 | 2 706 463 | 1 981 918 | 33 962 | 1 165 | 252 221 | 68 669 | 60 389 |
| 0141 | LIVESTOCK | 0.4 | C.L. | 1 069 984 | 23 628 | - | 955 448 | 2 255 | - | 22 339 | 110 | - | 31 771 | 15 | 34 418 |
| 10 • | METALLIC ORES | 0.8 | C.L. | 1 713 562 | 16 676 | 429 646 | 131 384 | 109 381 | - | 1 460 | 13 925 | - | 988 016 | 4 378 | 19 696 |
| 11 • | COAL | 1.0 | C.L. | 2 095 398 | 34 120 | 549 514 | 115 917 | 287 149 | - | 1 535 | 269 | - | 1 048 435 | 375 | 58 054 |
| 14 • | NONMETALLIC MINERALS | 0.6 | C.L. | 1 158 003 | 13 256 | 165 717 | 578 020 | 145 344 | - | 1 523 | 437 | 159 | 219 563 | 3 435 | 30 559 |
| 20 • | TOTAL OF 20 | 25.1 | C.L. | 57 013 849 | 1 245 218 | 1 563 365 | 35 502 172 | 1 522 072 | 9 005 900 | 523 149 | 724 372 | 66 296 | 5 106 245 | 372 287 | 382 773 |
| 2011 | FRESH MEAT | 4.7 | C.L. | 10 778 569 | 79 953 | 90 700 | 1 141 011 | 133 477 | 7 696 734 | 408 537 | 130 184 | 12 980 | 967 614 | 4 534 | 112 845 |
| 2012 | FROZEN MEAT | 0.2 | C.L. | 457 391 | 51 579 | 6 279 | 19 422 | 727 | 293 251 | 5 339 | 21 413 | 20 | 47 722 | - | 11 639 |
| 2013 | MEAT PRODUCTS | 0.5 | C.L. | 1 029 488 | 78 031 | 22 094 | 670 015 | 276 | 64 252 | 6 476 | 42 743 | 590 | 128 139 | 6 515 | 10 357 |
| 2015 | DRESSED POULTRY | 0.02 | C.L. | 40 902 | 2 918 | 433 | 34 028 | 1 931 | 106 | - | 1 333 | 153 | - | - | - |
| 2016 | FROZEN POULTRY | 0.04 | C.L. | 105 400 | 19 905 | 7 227 | 7 275 | 1 449 | 26 196 | 28 461 | 13 073 | - | 1 814 | - | - |
| 2031 | CANNED OR CURED SEA FOODS | 0.2 | C.L. | 556 411 | 77 120 | 4 953 | 366 354 | 510 | 20 269 | - | 35 140 | 38 | 42 771 | 2 142 | 114 |
| 2032 | CANNED SPECIALTIES | 0.1 | C.L. | 294 816 | 3 827 | 4 502 | 201 816 | 1 247 | - | - | 1 083 | 54 | 82 181 | - | 106 |
| 2033 | CANNED FRUITS OR VEGETABLES | 0.9 | C.L. | 2 163 213 | 49 576 | 7 276 | 1 869 473 | 4 618 | 18 851 | - | 16 119 | 11 616 | 164 639 | 7 264 | 13 781 |
| 2035 | PICKLED FRUITS OR VEGETABLES | 0.2 | C.L. | 350 842 | 6 748 | 3 244 | 282 541 | 240 | - | - | 2 240 | 1 094 | 54 735 | - | - |
| 2036 | FISH, PACKAGED | 0.02 | C.L. | 82 189 | 3 432 | 100 | 22 814 | 70 | 13 788 | - | 322 | - | 42 415 | - | 46 |
| 2037 | FROZEN FRUITS OR VEGETABLES | 0.3 | C.L. | 874 774 | 34 876 | [illegible] | [illegible] | 8 314 | 464 153 | 517 | 27 156 | [illegible] | [illegible] | | [illegible] |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | 0.8 | C.L. | 1 868 818 | 48 530 | 8 874 | 1 631 378 | 6 408 | 756 | 186 | 30 603 | - | 136 800 | 40 379 | 5 204 |
| 204 | GRAIN MILL PRODUCTS | 6.2 | C.L. | 14 102 963 | 95 356 | 478 731 | 11 658 389 | 716 076 | 13 571 | 34 401 | 42 557 | 3 549 | 928 313 | 51 487 | 80 533 |
| 2062 | SUGAR, REFINED | 1.1 | C.L. | 2 437 913 | 15 290 | 3 225 | 2 127 372 | 71 978 | - | - | 7 610 | 1 665 | 204 691 | 4 411 | 1 671 |
| 20821 | BEER | 1.1 | C.L. | 2 494 478 | 67 946 | 18 188 | 2 029 268 | 4 151 | 69 279 | 1 706 | 47 454 | 5 344 | 185 753 | 46 473 | 18 916 |
| 2084 | WINES, BRANDY | 0.3 | C.L. | 723 161 | 19 115 | 5 156 | 622 672 | 278 | 1 986 | - | 19 160 | 659 | 32 856 | 20 826 | 443 |
| 20851 | WHISKEY | 0.8 | C.L. | 1 972 032 | 145 724 | 32 101 | 1 536 110 | 1 613 | 2 261 | - | 73 818 | 8 437 | 165 954 | 4 753 | 1 261 |
| 2086 | SOFT DRINKS | 0.02 | C.L. | 54 738 | 1 763 | 29 | 52 659 | 10 | 20 | - | 4 | 253 | - | - | - |
| 209 | MISC. FOOD PREPARATIONS | 4.8 | C.L. | 11 020 660 | 249 574 | 689 835 | 8 288 181 | 344 213 | [illegible] 242 | 8 265 | 118 867 | 649 | 1 091 274 | 65 802 | 38 758 |
| 21 | TOBACCO PRODUCTS | 0.7 | C.L. | 1 626 798 | 53 690 | 45 333 | 999 757 | 98 357 | - | - | 288 433 | 3 131 | 137 657 | - | 440 |
| 24 | TOTAL OF 24 | 3.9 | C.L. | 8 874 055 | 100 162 | 77 586 | 6 069 103 | 100 015 | - | 13 356 | 24 198 | 42 693 | 1 932 852 | 447 358 | 66 732 |
| 2432 | PLYWOOD OR VENEER | 1.4 | C.L. | 3 245 309 | 14 664 | 2 631 | 2 430 456 | 24 816 | - | 1 416 | 1 335 | 295 | 656 091 | 110 067 | 3 518 |
| 25 | FURNITURE AND FIXTURES | 2.1 | C.L. | 4 898 507 | 90 717 | 18 326 | 3 427 299 | 35 038 | - | 116 | 45 246 | 823 929 | 389 243 | 68 593 | - |
| 26 | TOTAL OF 26 | 5.7 | C.L. | 13 085 591 | 79 904 | 28 503 | 10 027 810 | 149 364 | - | 4 653 | 31 790 | 20 339 | 2 352 319 | 327 877 | 63 012 |
| 26211 | NEWSPRINT | 1.2 | C.L. | 2 845 446 | 1 367 | 2 878 | 2 630 965 | 19 356 | - | - | 178 | 2 294 | 151 063 | 37 023 | 322 |
| 28 | CHEMICALS OR ALLIED PRODUCTS | 5.0 | C.L. | 11 849 394 | 210 118 | 268 247 | 7 280 746 | 370 724 | 49 102 | 10 903 | 89 182 | 8 126 | 3 325 987 | 113 608 | 122 651 |
| 29 | PETROLEUM OR COAL PRODUCTS | 0.9 | C.L. | 2 142 497 | 22 685 | 65 644 | 1 596 816 | 22 012 | - | 519 | 9 242 | 4 037 | 404 125 | 651 | 16 766 |
| 30 | RUBBER AND MISC. PLASTICS | 0.7 | C.L. | 1 574 940 | 244 297 | 75 137 | 556 928 | 9 462 | 389 | - | 233 992 | 4 888 | 328 917 | 120 937 | - |
| 32 | TOTAL OF 32 | 3.2 | C.L. | 7 316 535 | 58 236 | 118 490 | 5 885 724 | 161 121 | - | - | 15 426 | 344 286 | 834 753 | 48 024 | 50 475 |
| 321 | FLAT GLASS | 0.7 | C.L. | 1 606 095 | 1 330 | 1 845 | 1 416 018 | 13 741 | - | - | 69 | 67 668 | 102 325 | 2 964 | 135 |
| 322 | GLASSWARE | 0.2 | C.L. | 519 906 | 30 423 | 2 797 | 413 257 | 12 913 | - | - | 8 102 | 22 164 | 63 013 | 15 271 | 1 966 |
| 32511 | BRICK | 0.4 | C.L. | 903 280 | 3 545 | 17 617 | 858 242 | 27 | - | - | 208 | 2 180 | 21 366 | - | 95 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | 0.1 | C.L. | 199 524 | 220 | 694 | 171 453 | 1 301 | - | - | 398 | 1 769 | 14 906 | 7 815 | 968 |
| 33 | PRIMARY METAL PRODUCTS | 4.0 | C.L. | 9 136 349 | 252 896 | 214 141 | 6 125 129 | 199 950 | - | - | 281 469 | 18 619 | 1 861 914 | 95 847 | 86 384 |
| 34 | FABRICATED METAL PRODUCTS | 1.8 | C.L. | 4 186 632 | 80 274 | 18 582 | 2 932 986 | 38 801 | - | 1 026 | 19 138 | 74 922 | 946 125 | 55 774 | 19 004 |
| 35 | MACHINERY, EXCEPT ELECTRICAL | 2.6 | C.L. | 5 932 365 | 264 177 | 93 529 | 3 431 751 | 15 458 | - | 5 729 | 112 092 | 146 225 | 1 682 735 | 148 267 | 30 402 |
| 36 | TOTAL OF 36 | 4.3 | C.L. | 9 844 961 | 284 261 | 42 742 | 5 645 649 | 26 335 | - | - | 497 039 | 1 911 689 | 1 323 465 | 67 425 | 46 356 |
| 363 | HOUSEHOLD APPLIANCES | 2.7 | C.L. | 6 324 750 | 55 859 | 12 428 | 3 981 488 | 7 809 | - | - | 84 255 | 1 727 431 | 415 793 | 31 565 | 8 122 |
| 37 | TOTAL OF 37 | 15.5 | C.L. | 35 492 060 | 171 758 | 1 096 440 | 25 787 234 | 12 618 | - | 627 | 1 564 969 | 48 889 | 6 600 593 | 168 130 | 40 802 |
| 3711 | MOTOR VEHICLES | 13.3 | C.L. | 30 491 357 | 138 959 | 1 077 416 | 23 162 597 | 8 278 | - | 624 | 1 539 167 | 38 281 | 4 436 465 | 50 592 | 38 978 |
| 3714 | MOTOR VEHICLE PARTS | 1.5 | C.L. | 3 565 082 | 11 312 | 6 553 | 2 014 649 | 618 | - | - | 9 684 | 4 469 | 1 423 564 | 94 016 | 217 |
| 44 | FREIGHT FORWARDER TRAFFIC | 2.8 | C.L. | 6 356 104 | 418 662 | 54 965 | 3 108 002 | 22 773 | 14 252 | 1 134 | 378 434 | 810 959 | 1 442 886 | 92 714 | 11 318 |
| 45 | SHIPPER ASSOCIATION TRAFFIC | 1.9 | C.L. | 4 402 627 | 664 007 | 72 458 | 1 639 150 | 31 608 | 11 758 | 124 | 200 030 | 643 935 | 1 048 034 | 78 933 | 12 590 |
| | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | 5.2 | C.L. | 11 970 619 | 1 022 950 | 564 512 | 6 057 654 | 151 801 | 178 128 | 25 368 | 820 513 | 206 356 | 2 411 387 | 320 406 | 211 544 |
| 47 | L.C.L. | 1.2 | | 2 667 603 | 1 255 256 | 64 523 | 953 324 | 4 234 | 6 104 | 12 310 | 82 346 | 256 192 | 1 744 | 10 | 31 560 |
| | TOTAL (All 2-digit Items, except 47-L.C.L.) | 98.8 | C.L. | 225 648 786 | 5 683 581 | 9 621 735 | 134 185 634 | 6 082 929 | 14 093 341 | 3 937 118 | 5 450 820 | 4 983 897 | 36 781 024 | 3 334 428 | 1 494 279 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit Items) | 100.0 | | 228 316 389 | 6 938 837 | 9 686 258 | 135 138 958 | 6 087 163 | 14 099 445 | 3 949 428 | 5 533 166 | 5 240 089 | 36 782 768 | 3 334 438 | 1 525 839 |
| | PER CENT | | | 100.0 | 3.1 | 4.3 | 59.2 | 2.7 | 6.2 | 1.8 | 2.4 | 2.2 | 16.1 | 1.4 | 0.6 |
| | CAUSE SYMBOLS | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |

## COMMODITY COMPARISONS

1970 vs. 1969

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 01 * | TOTAL OF 01 | +20.8 | C.L. | $ 24 977 940 | 11.0 | 9.9 | $ 20 676 889 |
| 01121 | COTTON, IN BALES | - 5.6 | C.L. | 711 054 | 0.3 | 0.4 | 753 029 |
| 0113 | GRAIN | +19.3 | C.L. | 6 962 018 | 3.0 | 2.8 | 5 834 915 |
| 01144 | SOYBEANS | +37.2 | C.L. | 1 543 365 | 0.6 | 0.5 | 1 124 868 |
| 01195 | POTATOES, OTHER THAN SWEET | +10.4 | C.L. | 1 752 822 | 0.7 | 0.8 | 1 587 513 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | +13.6 | C.L. | 4 555 188 | 2.0 | 1.9 | 4 009 382 |
| 013 | ALL FRESH VEGETABLES | +32.0 | C.L. | 7 734 414 | 3.4 | 2.8 | 5 858 694 |
| 0141 | LIVESTOCK | + 6.2 | C.L. | 1 069 984 | 0.4 | 0.5 | 1 007 325 |
| 10 * | METALLIC ORES | +38.2 | C.L. | 1 713 562 | 0.8 | 0.6 | 1 239 548 |
| 11 * | COAL | - 8.4 | C.L. | 2 095 398 | 1.0 | 1.1 | 2 287 466 |
| 14 * | NONMETALLIC MINERALS | - 1.4 | C.L. | 1 158 003 | 0.6 | 0.6 | 1 171 365 |
| 20 * | TOTAL OF 20 | + 5.8 | C.L. | 57 013 849 | 25.1 | 25.6 | 53 880 283 |
| 2011 | FRESH MEAT | +29.9 | C.L. | 10 778 569 | 4.7 | 3.9 | 8 295 469 |
| 2012 | FROZEN MEAT | +14.8 | C.L. | 457 391 | 0.2 | 0.2 | 398 128 |
| 2013 | MEAT PRODUCTS | +11.9 | C.L. | 1 029 488 | 0.5 | 0.4 | 919 935 |
| 2015 | DRESSED POULTRY | -18.7 | C.L. | 40 902 | 0.02 | 0.02 | 50 261 |
| 2016 | FROZEN POULTRY | -25.4 | C.L. | 105 400 | 0.04 | 0.06 | 141 252 |
| 2031 | CANNED OR CURED SEA FOODS | + 0.1 | C.L. | 556 411 | 0.2 | 0.3 | 556 292 |
| 2032 | CANNED SPECIALTIES | - 7.5 | C.L. | 294 816 | 0.1 | 0.2 | 318 453 |
| 2033 | CANNED FRUITS OR VEGETABLES | -13.0 | C.L. | 2 163 213 | 0.9 | 1.2 | 2 484 581 |
| 2035 | PICKLED FRUITS OR VEGETABLES | -10.8 | C.L. | 350 842 | 0.2 | 0.2 | 393 049 |
| 2036 | FISH, PACKAGED | +71.7 | C.L. | 82 189 | 0.02 | 0.02 | 47 857 |
| 2037 | FROZEN FRUITS OR VEGETABLES | - 8.6 | C.L. | 874 774 | 0.3 | 0.5 | 957 053 |
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | - 5.5 | C.L. | 1 888 818 | 0.8 | 1.0 | 1 997 217 |
| 204 | GRAIN MILL PRODUCTS | + 1.1 | C.L. | 14 102 963 | 6.2 | 6.6 | 13 941 439 |
| 2062 | SUGAR, REFINED | -25.8 | C.L. | 2 437 913 | 1.1 | 1.6 | 3 282 976 |
| 20821 | BEER | + 4.7 | C.L. | 2 494 478 | 1.1 | 1.1 | 2 381 484 |
| 2084 | WINES, BRANDY | +33.1 | C.L. | 723 161 | 0.3 | 0.3 | 542 978 |
| 20851 | WHISKEY | - 9.4 | C.L. | 1 972 032 | 0.8 | 1.0 | 2 176 526 |
| 2086 | SOFT DRINKS | - 6.4 | C.L. | 54 738 | 0.02 | 0.03 | 58 345 |
| 209 | MISC. FOOD PREPARATIONS | +13.0 | C.L. | 11 020 660 | 4.8 | 4.6 | 9 747 053 |
| 21 * | TOBACCO PRODUCTS | - 6.1 | C.L. | 1 626 798 | 0.7 | 0.8 | 1 692 544 |

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 24 * | TOTAL OF 24 | -16.1 | C.L. | 8 874 055 | 3.9 | 5.0 | 10 574 623 |
| 2432 | PLYWOOD OR VENEER | -27.4 | C.L. | 3 245 309 | 1.4 | 2.1 | 4 467 406 |
| 25 * | FURNITURE AND FIXTURES | -15.0 | C.L. | 4 898 507 | 2.1 | 2.7 | 5 754 238 |
| 26 * | TOTAL OF 26 | + 5.5 | C.L. | 13 085 591 | 5.7 | 5.9 | 12 395 308 |
| 26211 | NEWSPRINT | -10.4 | C.L. | 2 845 446 | 1.2 | 1.5 | 3 173 808 |
| 28 * | CHEMICALS OR ALLIED PRODUCTS | + 9.2 | C.L. | 11 849 394 | 5.0 | 5.2 | 10 846 301 |
| 29 * | PETROLEUM OR COAL PRODUCTS | +16.7 | C.L. | 2 142 497 | 0.9 | 0.9 | 1 835 629 |
| 30 * | RUBBER AND MISC. PLASTICS | +57.4 | C.L. | 1 574 940 | 0.7 | 0.5 | 1 000 270 |
| 32 * | TOTAL OF 32 | + 1.6 | C.L. | 7 316 535 | 3.2 | 3.4 | 7 197 643 |
| 321 | FLAT GLASS | - 1.1 | C.L. | 1 606 095 | 0.7 | 0.8 | 1 623 576 |
| 322 | GLASSWARE | - 1.0 | C.L. | 549 906 | 0.2 | 0.3 | 554 995 |
| 32511 | BRICK | -11.1 | C.L. | 903 280 | 0.4 | 0.5 | 1 015 957 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | -12.0 | C.L. | 199 524 | 0.1 | 0.1 | 226 775 |
| 33 * | PRIMARY METAL PRODUCTS | + 7.0 | C.L. | 9 136 349 | 4.0 | 4.1 | 8 537 485 |
| 34 * | FABRICATED METAL PRODUCTS | - 2.1 | C.L. | 4 186 632 | 1.8 | 2.0 | 4 275 045 |
| 35 * | MACHINERY, EXCEPT ELECTRICAL | - 2.2 | C.L. | 5 932 365 | 2.6 | 2.9 | 6 065 280 |
| 36 * | TOTAL OF 36 | -24.5 | C.L. | 9 844 961 | 4.3 | 6.2 | 13 025 901 |
| 363 | HOUSEHOLD APPLIANCES | -27.1 | C.L. | 6 324 750 | 2.7 | 4.1 | 8 668 179 |
| 37 * | TOTAL OF 37 | +38.1 | C.L. | 35 492 060 | 15.5 | 12.2 | 25 689 427 |
| 3711 | MOTOR VEHICLES | +39.7 | C.L. | 30 491 357 | 13.3 | 10.3 | 21 814 900 |
| 3714 | MOTOR VEHICLE PARTS | +18.3 | C.L. | 3 565 082 | 1.5 | 1.4 | 3 006 876 |
| 44 * | FREIGHT FORWARDER TRAFFIC | -17.1 | C.L. | 6 356 104 | 2.8 | 3.6 | 7 660 908 |
| 45 * | SHIPPER ASSOCIATION TRAFFIC | +11.9 | C.L. | 4 402 627 | 1.9 | 1.9 | 3 933 687 |
| * | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | +41.8 | C.L. | 11 970 619 | 5.2 | 4.0 | 8 440 000 |
| 47 * | L.C.L. | +46.5 | | 2 667 603 | 1.2 | 0.9 | 1 920 323 |
| | TOTAL (All 2-digit items, except 47-L.C.L.) | + 8.3 | C.L. | 225 648 786 | 98.8 | 99.1 | 208 179 840 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit items) | + 8.7 | | 228 316 389 | 100.0 | 100.0 | 210 100 163 |

*Use 2-digit items only to obtain "TOTAL C.L." and "SUMMARY-C.L. and L.C.L. Combined", at bottom of statement.

# ASSOCIATION of AMERICAN RAILROADS

**OPERATIONS AND MAINTENANCE DEPARTMENT**

**FREIGHT CLAIM DIVISION**

**Chicago, Illinois**

**CALENDAR YEAR**

**1970**

## FREIGHT LOSS AND DAMAGE

REPORTED BY 78 CARRIERS REPRESENTING APPROXIMATELY 95 PER CENT OF UNITED STATES, CANADIAN AND MEXICAN MILEAGE.

| CAUSE SYMBOLS | | | | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | COMMODITIES | Per Cent of Total L&D | | TOTAL | Loss Entire Package | Loss Other Than Entire Package | Improper Handling—All Damage Not Otherwise Provided For | Defective or Unfit Equipment | Temperature Failures | Delay | Theft | Concealed Damage | Train Accident | Fire, Marine and Catastrophes | Error of Employee |
| 01 * | TOTAL OF 01 | 11.0 | C.L. | $ 24 977 940 | $ 355 517 | $4 056 865 | $6 286 403 | $2 573 521 | $4 833 812 | $3 345 906 | $ 100 624 | $ 4 419 | $ 2 395 773 | $ 799 409 | $ 225 691 |
| 01121 | COTTON, IN BALES | 0.3 | C.L. | 711 054 | 5 938 | 976 | 25 714 | 35 378 | - | - | 790 | - | 58 163 | 583 211 | 884 |
| 0113 | GRAIN | 3.0 | C.L. | 6 962 018 | 16 607 | 2 978 816 | 296 255 | 2 082 076 | - | 131 006 | 20 007 | 160 | 1 325 826 | 16 860 | 94 405 |
| 01144 | SOYBEANS | 0.6 | C.L. | 1 543 365 | 2 660 | 899 372 | 56 395 | 299 749 | - | 23 961 | 3 830 | - | 252 479 | 192 | 4 727 |
| 01195 | POTATOES, OTHER THAN SWEET | 0.7 | C.L. | 1 752 822 | 55 336 | 26 012 | 734 989 | 20 974 | 502 206 | 281 811 | 12 998 | 112 | 54 924 | 45 155 | 18 305 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | 2.0 | C.L. | 4 555 188 | 125 747 | 28 014 | 1 575 413 | 23 441 | 1 591 699 | 887 185 | 26 124 | 313 | 215 804 | 69 029 | 12 419 |
| 013 | ALL FRESH VEGETABLES | 3.4 | C.L. | 7 734 414 | 114 206 | 74 982 | 2 381 475 | 58 964 | 2 706 463 | 1 981 918 | 33 962 | 1 165 | 252 221 | 68 669 | 60 389 |
| 0141 | LIVESTOCK | 0.4 | C.L. | 1 069 984 | 23 628 | - | 955 448 | 2 255 | - | 22 339 | 110 | - | 31 771 | 15 | 34 418 |
| 10 * | METALLIC ORES | 0.8 | C.L. | 1 713 562 | 16 676 | 429 646 | 131 384 | 109 381 | - | 1 460 | 13 925 | - | 988 016 | 4 378 | 18 696 |
| 11 * | COAL | 1.0 | C.L. | 2 095 398 | 34 120 | 549 514 | 115 917 | 287 149 | - | 1 535 | 269 | - | 1 048 435 | 375 | 58 084 |
| 14 * | NONMETALLIC MINERALS | 0.6 | C.L. | 1 158 003 | 13 256 | 165 717 | 578 020 | 145 344 | - | 1 513 | 437 | 159 | 219 563 | 3 435 | 30 559 |
| 20 * | TOTAL OF 20 | 25.1 | C.L. | 57 013 849 | 1 245 218 | 1 563 365 | 36 502 172 | 1 522 072 | 9 005 900 | 523 149 | 724 372 | 66 296 | 5 106 245 | 372 287 | 382 773 |
| 2011 | FRESH MEAT | 4.7 | C.L. | 10 778 569 | 79 953 | 90 700 | 1 141 011 | 133 477 | 7 696 734 | 408 537 | 130 184 | 12 980 | 967 614 | 4 534 | 112 845 |
| 2012 | FROZEN MEAT | 0.2 | C.L. | 457 391 | 51 579 | 6 279 | 19 422 | 727 | 293 251 | 5 339 | 21 413 | 20 | 47 722 | - | 11 639 |
| 2013 | MEAT PRODUCTS | 0.5 | C.L. | 1 029 488 | 78 031 | 22 094 | 670 015 | 276 | 64 252 | 6 476 | 42 743 | 590 | 128 139 | 6 515 | 10 357 |
| 2015 | DRESSED POULTRY | 0.02 | C.L. | 40 902 | 2 918 | 433 | 34 028 | 1 931 | 106 | - | 1 333 | 153 | - | - | - |
| 2016 | FROZEN POULTRY | 0.04 | C.L. | 105 400 | 19 905 | 7 227 | 7 275 | 1 449 | 26 196 | 28 461 | 13 073 | - | 1 814 | - | - |
| 2031 | CANNED OR CURED SEA FOODS | 0.2 | C.L. | 556 411 | 77 120 | 4 953 | 366 354 | 510 | 20 269 | - | 35 140 | 38 | 49 771 | 2 142 | 114 |
| 2022 | CANNED SPECIALTIES | 0.1 | C.L. | 294 816 | 3 827 | 4 502 | 201 816 | 1 247 | - | - | 1 083 | 54 | 82 181 | - | 106 |
| 2033 | CANNED FRUITS OR VEGETABLES | 0.9 | C.L. | 2 163 213 | 49 576 | 7 276 | 1 869 473 | 4 618 | 18 851 | - | 16 119 | 11 616 | 164 639 | 7 264 | 13 781 |
| 2035 | PICKLED FRUITS OR VEGETABLES | 0.2 | C.L. | 350 842 | 6 748 | 3 244 | 282 541 | 240 | - | - | 2 240 | 1 094 | 54 735 | - | - |
| 2036 | FISH, PACKAGED | 0.02 | C.L. | 82 189 | 3 432 | 100 | 22 014 | 70 | 13 788 | - | 322 | - | 42 415 | - | 48 |
| 2037 | FROZEN FRUITS OR VEGETABLES | 0.3 | C.L. | 874 774 | 34 876 | 14 313 | 158 143 | 8 314 | 484 151 | 547 | 27 156 | 356 | 129 634 | - | 17 284 |
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | 0.8 | C.L. | 1 888 818 | 48 530 | 8 874 | 1 611 378 | 6 408 | 756 | 186 | 30 603 | - | 136 600 | 40 379 | 5 104 |
| 204 | GRAIN MILL PRODUCTS | 6.2 | C.L. | 14 102 963 | 95 356 | 478 731 | 11 658 389 | 716 076 | 13 571 | 34 401 | 42 557 | 3 549 | 928 313 | 51 487 | 80 533 |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2062 | SUGAR, REFINED | 1.1 | C.L. | 2 437 913 | 15 290 | 3 225 | 2 127 372 | 71 978 | - | - | 7 610 | 1 665 | 204 691 | 4 411 | 1 671 |
| 20821 | BEER | 1.1 | C.L. | 2 494 478 | 67 946 | 18 188 | 2 029 268 | 4 151 | 69 279 | 1 706 | 47 454 | 5 344 | 185 753 | 46 473 | 18 916 |
| 2084 | WINES, BRANDY | 0.3 | C.L. | 723 161 | 19 115 | 5 156 | 622 672 | 278 | 1 996 | - | 19 160 | 659 | 32 856 | 20 826 | 443 |
| 20851 | WHISKEY | 0.8 | C.L. | 1 972 032 | 145 724 | 32 101 | 1 536 110 | 1 613 | 2 261 | - | 73 818 | 8 437 | 165 954 | 4 753 | 1 261 |
| 2086 | SOFT DRINKS | 0.02 | C.L. | 54 738 | 1 763 | 29 | 52 659 | 10 | 20 | - | 4 | 253 | - | - | - |
| 209 | MISC. FOOD PREPARATIONS | 4.8 | C.L. | 11 020 660 | 249 574 | 689 835 | 8 288 181 | 344 213 | 105 242 | 8 265 | 118 867 | 649 | 1 091 274 | 65 802 | 38 758 |
| 21 * | TOBACCO PRODUCTS | 0.7 | C.L. | 1 626 798 | 53 690 | 45 333 | 999 757 | 98 357 | - | - | 288 433 | 3 131 | 137 657 | - | 440 |
| 24 * | TOTAL OF 24 | 3.9 | C.L. | 8 874 055 | 100 162 | 77 586 | 6 069 103 | 100 015 | - | 13 356 | 24 198 | 42 693 | 1 932 852 | 447 358 | 66 732 |
| 2432 | PLYWOOD OR VENEER | 2.4 | C.L. | 3 245 309 | 14 664 | 2 631 | 2 430 456 | 24 816 | - | 1 416 | 1 335 | 295 | 656 091 | 110 087 | 3 518 |
| 25 * | FURNITURE AND FIXTURES | 2.1 | C.L. | 4 898 507 | 90 717 | 18 326 | 3 427 299 | 35 038 | - | 116 | 45 246 | 823 929 | 389 243 | 68 593 | - |
| 26 * | TOTAL OF 26 | 5.7 | C.L. | 13 085 591 | 79 904 | 28 503 | 10 027 810 | 149 384 | - | 4 653 | 31 790 | 20 339 | 2 352 319 | 327 877 | 63 012 |
| 26211 | NEWSPRINT | 1.2 | C.L. | 2 845 446 | 1 367 | 2 878 | 2 630 965 | 19 356 | - | - | 178 | 2 294 | 151 063 | 37 023 | 322 |
| 28 * | CHEMICALS OR ALLIED PRODUCTS | 5.0 | C.L. | 11 849 394 | 210 118 | 268 247 | 7 280 746 | 370 724 | 49 102 | 10 903 | 89 182 | 8 126 | 3 325 987 | 113 608 | 122 651 |
| 29 * | PETROLEUM OR COAL PRODUCTS | 0.9 | C.L. | 2 142 497 | 22 685 | 65 644 | 1 596 816 | 22 012 | - | 519 | 9 242 | 4 037 | 404 125 | 651 | 16 766 |
| 30 * | RUBBER AND MISC. PLASTICS | 0.7 | C.L. | 1 574 940 | 244 297 | 75 130 | 556 928 | 9 462 | 389 | - | 233 992 | 4 888 | 328 917 | 120 937 | - |
| 32 * | TOTAL OF 32 | 3.2 | C.L. | 7 316 535 | 58 236 | 118 490 | 5 885 724 | 161 121 | - | - | 15 426 | 244 286 | 834 753 | 48 024 | 50 475 |
| 321 | FLAT GLASS | 0.7 | C.L. | 1 606 095 | 1 330 | 1 845 | 1 416 018 | 13 741 | - | - | 69 | 67 668 | 102 325 | 2 964 | 135 |
| 322 | GLASSWARE | 0.2 | C.L. | 549 906 | 10 423 | 2 797 | 413 257 | 12 913 | - | - | 8 102 | 22 164 | 63 013 | 15 271 | 1 966 |
| 32511 | BRICK | 0.4 | C.L. | 903 280 | 3 545 | 17 617 | 858 242 | 27 | - | - | 208 | 2 180 | 21 366 | - | 95 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | 0.1 | C.L. | 199 524 | 220 | 694 | 171 453 | 1 301 | - | - | 398 | 1 769 | 14 906 | 7 815 | 968 |
| 33 * | PRIMARY METAL PRODUCTS | 4.0 | C.L. | 9 136 349 | 252 896 | 214 141 | 6 125 129 | 199 950 | - | - | 281 469 | 18 619 | 1 861 914 | 95 847 | 86 384 |
| 34 * | FABRICATED METAL PRODUCTS | 1.8 | C.L. | 4 186 632 | 80 274 | 18 582 | 2 932 986 | 38 801 | - | 1 026 | 19 138 | 74 922 | 946 125 | 55 774 | 19 004 |
| 35 * | MACHINERY, EXCEPT ELECTRICAL | 2.6 | C.L. | 5 932 365 | 264 177 | 95 529 | 3 431 751 | 15 458 | - | 5 729 | 112 092 | 146 225 | 1 682 735 | 148 267 | 30 402 |
| 36 * | TOTAL OF 36 | 4.3 | C.L. | 9 844 961 | 284 261 | 42 742 | 5 645 649 | 26 335 | - | - | 497 039 | 1 911 689 | 1 323 465 | 67 425 | 46 356 |
| 363 | HOUSEHOLD APPLIANCES | 2.7 | C.L. | 6 324 750 | 55 859 | 12 428 | 3 981 488 | 7 809 | - | - | 84 255 | 1 727 431 | 415 793 | 31 565 | 8 122 |
| 37 * | TOTAL OF 37 | 15.5 | C.L. | 35 492 060 | 171 758 | 1 096 440 | 25 787 234 | 12 618 | - | 627 | 1 564 969 | 48 889 | 6 600 593 | 168 130 | 40 802 |
| 3711 | MOTOR VEHICLES | 13.3 | C.L. | 30 491 357 | 138 959 | 1 077 416 | 23 162 597 | 8 278 | - | 624 | 1 539 167 | 38 281 | 4 436 465 | 50 592 | 38 978 |
| 3714 | MOTOR VEHICLE PARTS | 1.5 | C.L. | 3 565 082 | 11 312 | 6 553 | 2 014 649 | 618 | - | - | 9 684 | 4 469 | 1 423 564 | 94 016 | 217 |
| 44 * | FREIGHT FORWARDER TRAFFIC | 2.8 | C.L. | 6 356 104 | 418 662 | 54 965 | 3 108 002 | 22 773 | 14 252 | 1 134 | 378 434 | 810 959 | 1 442 886 | 92 714 | 11 318 |
| 45 * | SHIPPER ASSOCIATION TRAFFIC | 1.9 | C.L. | 4 402 627 | 664 007 | 72 458 | 1 639 150 | 31 608 | 11 758 | 124 | 200 030 | 643 935 | 1 048 034 | 78 933 | 12 590 |
| * | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | 5.2 | C.L. | 11 970 619 | 1 022 950 | 564 512 | 6 057 654 | 151 801 | 178 128 | 25 368 | 820 513 | 206 356 | 2 411 387 | 320 406 | 211 544 |
| 47 * | L.C.L. | 1.2 | | 2 667 603 | 1 255 256 | 64 523 | 953 324 | 4 234 | 6 104 | 12 310 | 82 346 | 256 192 | 1 744 | 10 | 31 560 |
| | TOTAL (All 2-digit items, except 47-L.C.L.) | 98.8 | C.L. | 225 648 786 | 5 683 581 | 9 621 735 | 134 185 634 | 6 082 929 | 14 093 341 | 3 937 118 | 5 450 820 | 4 983 897 | 36 781 024 | 3 334 428 | 1 494 279 |
| | SUMMARY – C.L. and L.C.L. Combined (All 2-digit items) | 100.0 | | 228 316 389 | 6 938 837 | 9 686 258 | 135 138 958 | 6 087 163 | 14 099 445 | 3 949 428 | 5 533 166 | 5 240 089 | 36 782 768 | 3 334 438 | 1 525 839 |
| | PER CENT | | | 100.0 | 3.1 | 4.3 | 59.2 | 2.7 | 6.2 | 1.8 | 2.4 | 2.2 | 16.1 | 1.4 | 0.6 |
| | **CAUSE SYMBOLS** | | | | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |

Figure 5

COMMODITY COMPARISONS

1970 vs. 1969

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 01 * | TOTAL OF 01 | +20.8 | C.L. | $ 24 977 940 | 11.0 | 9.9 | $ 20 676 889 |
| 01121 | COTTON, IN BALES | - 5.6 | C.L. | 711 054 | 0.3 | 0.4 | 753 029 |
| 0113 | GRAIN | +19.3 | C.L. | 6 962 018 | 3.0 | 2.8 | 5 834 915 |
| 01144 | SOYBEANS | +37.2 | C.L. | 1 543 365 | 0.6 | 0.5 | 1 124 868 |
| 01195 | POTATOES, OTHER THAN SWEET | +10.4 | C.L. | 1 752 822 | 0.7 | 0.8 | 1 587 513 |
| 012 | ALL FRESH FRUITS AND TREE NUTS | +13.6 | C.L. | 4 555 188 | 2.0 | 1.9 | 4 009 382 |
| 013 | ALL FRESH VEGETABLES | +32.0 | C.L. | 7 734 414 | 3.4 | 2.8 | 5 858 694 |
| 0141 | LIVESTOCK | + 6.2 | C.L. | 1 069 984 | 0.4 | 0.5 | 1 007 325 |
| 10 * | METALLIC ORES | +38.2 | C.L. | 1 713 562 | 0.8 | 0.6 | 1 239 548 |
| 11 * | COAL | - 8.4 | C.L. | 2 095 398 | 1.0 | 1.1 | 2 287 466 |
| 14 * | NONMETALLIC MINERALS | - 1.4 | C.L. | 1 158 003 | 0.6 | 0.6 | 1 171 365 |
| 20 * | TOTAL OF 20 | + 5.8 | C.L. | 57 013 849 | 25.1 | 25.6 | 53 880 283 |
| 2011 | FRESH MEAT | +29.9 | C.L. | 10 778 569 | 4.7 | 3.9 | 8 295 469 |
| 2012 | FROZEN MEAT | +14.8 | C.L. | 457 391 | 0.2 | 0.2 | 398 128 |
| 2013 | MEAT PRODUCTS | +11.9 | C.L. | 1 029 488 | 0.5 | 0.4 | 919 935 |
| 2015 | DRESSED POULTRY | -18.7 | C.L. | 40 902 | 0.02 | 0.02 | 50 261 |
| 2016 | FROZEN POULTRY | -25.4 | C.L. | 105 400 | 0.04 | 0.06 | 141 252 |
| 2031 | CANNED OR CURED SEA FOODS | + 0.1 | C.L. | 556 411 | 0.2 | 0.3 | 556 292 |
| 2032 | CANNED SPECIALTIES | - 7.5 | C.L. | 294 816 | 0.1 | 0.2 | 318 453 |
| 2033 | CANNED FRUITS OR VEGETABLES | -13.0 | C.L. | 2 163 213 | 0.9 | 1.2 | 2 484 581 |
| 2035 | PICKLED FRUITS OR VEGETABLES | -10.8 | C.L. | 350 842 | 0.2 | 0.2 | 393 049 |
| 2036 | FISH, PACKAGED | +71.7 | C.L. | 82 189 | 0.02 | 0.02 | 47 857 |
| 2037 | FROZEN FRUITS OR VEGETABLES | - 8.6 | C.L. | 874 774 | 0.3 | 0.5 | 957 053 |
| 2039 | MIXED SHIPMENTS OF CANNED GOODS | - 5.5 | C.L. | 1 888 818 | 0.8 | 1.0 | 1 997 217 |
| 204 | GRAIN MILL PRODUCTS | + 1.1 | C.L. | 14 102 963 | 6.2 | 6.6 | 13 941 439 |
| 2062 | SUGAR, REFINED | -25.8 | C.L. | 2 437 913 | 1.1 | 1.6 | 3 282 976 |
| 20821 | BEER | + 4.7 | C.L. | 2 494 478 | 1.1 | 1.1 | 2 381 484 |
| 2084 | WINES, BRANDY | +33.1 | C.L. | 723 161 | 0.3 | 0.3 | 542 978 |
| 20851 | WHISKEY | - 9.4 | C.L. | 1 972 032 | 0.8 | 1.0 | 2 176 526 |
| 2086 | SOFT DRINKS | - 6.4 | C.L. | 54 738 | 0.02 | 0.03 | 58 345 |
| 209 | MISC. FOOD PREPARATIONS | +13.0 | C.L. | 11 020 660 | 4.8 | 4.6 | 9 747 053 |
| 21 * | TOBACCO PRODUCTS | - 6.1 | C.L. | 1 626 798 | 0.7 | 0.8 | 1 692 544 |

| | COMMODITIES | Per Cent Inc. or Dec. | | TOTAL 1970 | Per Cent To Total L & D 1970 | 1969 | TOTAL 1969 |
|---|---|---|---|---|---|---|---|
| 24 * | TOTAL OF 24 | -16.1 | C.L. | 8 874 055 | 3.9 | 5.0 | 10 574 623 |
| 2432 | PLYWOOD OR VENEER | -27.4 | C.L. | 3 245 309 | 1.4 | 2.1 | 4 467 406 |
| 25 * | FURNITURE AND FIXTURES | -15.0 | C.L. | 4 898 507 | 2.1 | 2.7 | 5 754 238 |
| 26 * | TOTAL OF 26 | + 5.5 | C.L. | 13 085 591 | 5.7 | 5.9 | 12 395 308 |
| 26211 | NEWSPRINT | -10.4 | C.L. | 2 845 446 | 1.2 | 1.5 | 3 173 808 |
| 28 * | CHEMICALS OR ALLIED PRODUCTS | + 9.2 | C.L. | 11 849 394 | 5.0 | 5.2 | 10 846 301 |
| 29 * | PETROLEUM OR COAL PRODUCTS | +16.7 | C.L. | 2 142 497 | 0.9 | 0.9 | 1 835 629 |
| 30 * | RUBBER AND MISC. PLASTICS | +57.4 | C.L. | 1 574 940 | 0.7 | 0.5 | 1 000 270 |
| 32 * | TOTAL OF 32 | + 1.6 | C.L. | 7 316 535 | 3.2 | 3.4 | 7 197 643 |
| 321 | FLAT GLASS | - 1.1 | C.L. | 1 606 095 | 0.7 | 0.8 | 1 623 576 |
| 322 | GLASSWARE | - 1.0 | C.L. | 549 906 | 0.2 | 0.3 | 554 995 |
| 32511 | BRICK | -11.1 | C.L. | 903 280 | 0.4 | 0.5 | 1 015 957 |
| 3259 | MISC. STRUCTURAL CLAY PRODUCTS | -12.0 | C.L. | 199 524 | 0.1 | 0.1 | 226 775 |
| 33 * | PRIMARY METAL PRODUCTS | + 7.0 | C.L. | 9 136 349 | 4.0 | 4.1 | 8 537 485 |
| 34 * | FABRICATED METAL PRODUCTS | - 2.1 | C.L. | 4 186 632 | 1.8 | 2.0 | 4 275 045 |
| 35 * | MACHINERY, EXCEPT ELECTRICAL | - 2.2 | C.L. | 5 932 365 | 2.6 | 2.9 | 6 065 280 |
| 36 * | TOTAL OF 36 | -24.5 | C.L. | 9 844 961 | 4.3 | 6.2 | 13 025 901 |
| 363 | HOUSEHOLD APPLIANCES | -27.1 | C.L. | 6 324 750 | 2.7 | 4.1 | 8 668 179 |
| 37 * | TOTAL OF 37 | +38.1 | C.L. | 35 492 060 | 15.5 | 12.2 | 25 689 427 |
| 3711 | MOTOR VEHICLES | +39.7 | C.L. | 30 491 357 | 13.3 | 10.3 | 21 814 900 |
| 3714 | MOTOR VEHICLE PARTS | +18.3 | C.L. | 3 565 082 | 1.5 | 1.4 | 3 006 876 |
| 44 * | FREIGHT FORWARDER TRAFFIC | -17.1 | C.L. | 6 356 104 | 2.8 | 3.6 | 7 660 908 |
| 45 * | SHIPPER ASSOCIATION TRAFFIC | +11.9 | C.L. | 4 402 627 | 1.9 | 1.9 | 3 933 687 |
| * | ALL OTHERS-08-09-13-19-22 23-27-31-38-39-40-41-42-46 | +41.8 | C.L. | 11 970 619 | 5.2 | 4.0 | 8 440 000 |
| 47 * | L.C.L. | +46.5 | | 2 667 603 | 1.2 | 0.9 | 1 920 323 |
| | TOTAL (All 2-digit items, except 47-L.C.L.) | + 8.3 | C.L. | 225 648 786 | 98.8 | 99.1 | 208 179 840 |
| | SUMMARY — C.L. and L.C.L. Combined (All 2-digit items) | + 8.7 | | 228 316 389 | 100.0 | 100.0 | 210 100 163 |

*Use 2-digit items only to obtain "TOTAL C.L." and "SUMMARY-C.L. and L.C.L. Combined", at bottom of statement.

ɔOCIATION OF
AMERICAN RAILROADS
OPERATIONS AND MAINTENANCE DEPARTMENT • FREIGHT CLAIM DIVISION
59 EAST VAN BUREN STREET • CHICAGO, ILLINOIS 60605

R. R. MANION
Vice-President



May 13, 1971

CIRCULAR NO. FCD-2198

File 300-9

Freight Loss and Damage 1970

TO THE MEMBERS:

Submitted herein is a tabulation, by principal causes and commodity groups, of freight loss and damage reported by member carriers (U.S., Canadian & Mexican) for the year 1970.

It will be observed that the total loss and damage was $228,316,389, an increase of $18,216,226 or 8.7% over $210,100,163 reported in 1969.

The ratio of loss and damage charges to gross freight revenue of U. S. Railroads was 1.97% compared with 1.92% in 1969.

A total of $26,840,905 was carried in the suspense accounts of the carriers at the close of 1970, pending charges to other involved lines. This was an increase of 13.1% compared with the amount reported at close of 1969.

New claims presented to the member railroads during 1970 (which represent potential charges to the Freight Loss and Damage Account of the future) totaled 2,633,146, an increase of 160,406 claims, or 6.5% over 1969.

Respectfully,

J. C. Hindman,

Secretary

## III CARGO SECURITY EQUIPMENT APPLICATIONS

In response to legislation proposed as an outgrowth of the Hearings of the Senate Select Committee on Small Business affecting cargo security and promotion of programs to prevent cargo theft, loss, and damage, the Department of Transportation established the Interagency Committee on Transportation Security.

In a report prepared by the Congressional Library Research Service for the Senate Committee on Small Business, the rail carrier cargo theft and pilferage losses for the calendar year 1970 were estimated at $250,000,000. (The total direct loss for all modes of transportation was estimated at $1.47 billion. The addition of indirect costs, such as administrative costs, processing claims costs, lost business and profit costs, raised the estimate to $8-10 billion.)

The cargo in transit moves across jurisdictional boundaries, and the problem of determining responsibility for cargo theft is difficult. Cargo may originate in one jurisdiction, cross another, be transshipped in a third, stored in a fourth, and delivered in a fifth. When the cargo is stolen, the determination of the responsible transportation agency and legal authority having jurisdiction may be difficult, especially when the first notification of the theft may be the non-arrival of the cargo at its intended destination.

The theft of cargo in transit may be accomplished by the forcible take-over of vehicles (hijacking), but it is more commonly accomplished by taking or entering a transport vehicle or container while temporarily stationary. Those railroad cars on sidings or in switch yards, and the containers at intermodal transfer points, are vulnerable to theft. And because these vehicles are temporarily stationary, permanent security barriers or alarm systems are usually non-applicable.

Modern freight cars and standard shipping containers are of substantial construction but are commonly secured only by a metal strip car-seal. This seal indicates whether the vehicle has been opened prior to delivery, but provides no physical protection. Heavy duty security locks could be used, and in some cases are, but the problem of assuring that the proper key for opening the lock will be available on arrival at the final destination has inhibited the use of such locks for common carrier vehicles.

Mechanical fastening devices which require heavy tools, and non-available to the general public, are under investigation. Three types of such devices suitable for securing freight car doors are being tested. The devices are a heavy braided wire to secure the door hasp, a special C-clamp to secure the freight car roller track, and the use of a pin stud to secure the roller track. These devices require special purpose tools for their removal. With the proper use of these devices, it is expected that pilferage and thefts from temporarily exposed rail cars and containers could be reduced. The damage that follows the opening of cars or containers, such as spoilage and breakage, should also be reduced.

With the majority of cargo thefts occurring when the cars are temporarily halted, such electric protection devices as simple vibration switches, accelerometers, pressure switches, magnetic coil devices and capacitance sensors which have been used successfully to protect high value items in storage, may be adapted for the protection of vehicles or containers when temporarily halted. Mechanical and magnetic door switches may be modified for use with doors so that the unauthorized entry can be reported to a monitor station. Such remote observation devices as regular or low-light level TV, audio monitors and Doppler radar may be used to monitor the switch yards and terminals.

Railroad cars and containers have been diverted by the simple means of having their legitimate identification painted over and false identification substituted. The freight vehicles and containers are commonly identified by the name and identity code of the owning company, and a serial number. More permanent vehicle identification schemes, such as an embossed metal panel, should prevent or make more difficult, such alterations. The railroad cars and containers are also commonly identified with ACI (Automatic Car Identifier) code panels, which are scanned and read by electronic equipment.

Since the primary function of transportation is to move cargo economically and expeditiously, it is necessary to maintain the freedom of movement and access to personnel and vehicles involved with legitimate cargo movement. The security measures should be such as not to impede legitimate movement and access.

The use of such physical protective devices as fences, walls, gates, doors, lights, and locks do not provide total protection. Physical protective devices are a means to control access to cargo handling and storage areas, and thereby making proper supervision more manageable. The advantage of electrical protective devices is that they can control or monitor activities without restricting legitimate activity.

The intent of specific physical protection devices for a transportation facility is to impede and prohibit diverse forms of criminal activity. Where the act of theft is not deterred, the intent is to make the act more difficult, more time consuming, obviously illegal, and to discourage the successful completion.

One of the basic safeguards in protecting installations, personnel and property is the lock. However, locks, regardless of quality or cost, should be considered delay devices only, and not positive bars to entry. The locks can be overwhelmed by force and the proper tools.

The types of locks to be described are the following:

(a) Key Locks

(b) Conventional Combination Locks

(c) Manipulation-Resistant Combination Locks

(d) Relocking Devices

(e) Interchangeable Cores

The key lock can be picked by an expert in a few minutes. The possibility of the loss of a key and the ease with which an impression may be made should be considered in the security evaluation of a key-type lock.

The conventional combination lock may also be opened by a skilled operator, who through touch and hearing may be able to determine the settings of the tumblers and construction of a common three-position dial-type combination lock. Although the manipulation of some combination locks may require several hours, the skilled operator can open an average conventional combination lock in a few minutes.

The manipulation-resistant combination lock is so designed that the opening lever does not come in contact with the tumblers until the combination has been set. This type lock furnishes a high degree of protection.

The relocking devices furnish an added degree of security against forcible entry. Such a device appreciably increases the difficulty of opening a combination lock container by punching, drilling or blocking the lock or its parts. A relocking device is recommended for safes and vaults.

The interchangeable core system utilizes a type of lock with a core that can be removed and replaced by another core using a different key. Its main features includes: cores may be quickly replaced, instantly changing the matching of locks and keys if their security is comprised; all locks can be keyed into an overall complete master-keyed locking system; the maintenance costs are low; and the record keeping is simplified.

The use of physical barriers may be supplemented, made more effective or even replaced by the proper application of electric intrusion detection and alarm systems. The surveillance of activity in a security area may be performed by remote monitoring equipment.

The intrusion detection and alarm devices must be simple, reliable, reasonable in cost and, above all, suitable to the application. The electric protection devices can make the existing security forces, and the physical protection barriers, more effective. They can be used to reduce the number of security personnel or the degree of physical protection required, thereby minimizing the overall cost of a security program. The use of electrical protective devices, used to control activities within terminals and storage areas or to monitor the access to sensitive areas, have the advantage in not restricting the legitimate activity of authorized personnel and vehicles.

The electrical protection system for the detection of theft or intrusion consists of sensors, alarm lines, monitor stations and a reaction force for the prompt and effective response. The selection, application and use of the electrical protective devices for intrusion detection and remote monitoring are described in this section.

Perimeter sensors are intrusion detection devices that detect and report the crossing of a boundary line by persons or vehicles. It converts the detection to an electrical signal and transmits an alarm whenever the signal exhibits the characteristics of an intrusion. The sensors are generally placed near the most likely points of break-in. The earliest detection is achieved by locating the sensors on or near the fences and gates surrounding a protected area. Other sensors may be located in the storage room or cage, or on the protected cargo itself. The use of radar or light beams to sense intruders approaching the fence line are also known to be effective.

The sensor, by providing continuous monitoring, maintains the fence as an effective barrier at night, in nonworking hours and in the absence of visual surveillance by guards. The use of effective perimeter sensors with a central monitor may reduce the manpower requirement by reducing the requirement for expensive observation posts and roving patrols.

Perimeter sensors are commonly used, with or without fences, to isolate areas used for the delivery or storage of cargo from those areas used for the removal of cargo. Many of these sensors impose no physical barrier when used alone, and therefore are well adapted for situations where free access is required during working hours.

The photo-electric beam sensor consists of a beam of visible light or infrared radiation projected toward a photocell receiver. When the beam is blocked momentarily, as it might be when an intruder crosses between the projector and receiver, an alarm is generated. The photo-electric beam sensor is a narrow-beam line-of-sight device, and this means that the receiver must always be located on the axis of the projected beam and the intrusion can only be detected if it crosses that axis. It generally is used parallel and adjacent to fence lines, but it can be used to protect open spaces and wide entrances where fences and gates cannot be used, such as at railroad tracks, multi-track railroad entrances and the like. With some devices the maximum range of detection is up to 1000 feet of total beam length. As with any optical device, the photo-electric beam sensor is affected by the environment. Its effective range can be reduced by rain, fog and smoke, or frost on the lens. The lenses and mirrors must be cleaned frequently.

The microwave/radar sensor is a broad-beam line-of-sight device, which means that off-axis detection is possible, but that the line of detection must be clear of obstruction. Any fixed object in the field of vision can shield an intruder and thus by-pass the sensor. This type of sensor is generally used to cover short perimeters, selected open spaces or wide entrances or gates.

This sensor consists of a radio wave transmitter/receiver pointed along the perimeter line. When an intruder enters the protected field a portion of the wave is reflected to the reciever. The motion of the intruder causes the frequency of the reflected wave to differ from the frequency of the background reflection, and an alarm is generated.

The microwave/radar sensor is relatively insensitive to the environment, but is highly sensitive to blowing trash and moving foliage. It would false alarm adversely unless the sensor were carefully sited and cleared.

The balanced pressure sensor is used for detecting intruders by sensing the slight changes in differential pressure under the soil. This sensor consists of two liquid filled hoses about four feet apart and connected at one end to a differential pressure sensor. When a momentary pressure differential is sensed, the alarm is generated. The hoses generally are in lengths to 300 feet and can be buried along fence lines or across open spaces.

The balanced pressure sensor is similar to a narrow-beam device in being sensitive along a narrow lane centered on the hose line. It is generally buried about 12-15 inches, and is dependent on the elasticity of the soil to transmit the detection pressure. A reduction in this elasticity by rocky soil or freezing temperatures, reduces the sensitivity of the device and limits its ability to detect intruders. It is best used in temperate climates, in homogeneous soil, along open fence lines free of nearby trees. The trees that wave in the wind can increase the false alarm rate and reduce its effectiveness.

There are devices available that can detect the breaking through of walls, roofs and floors. Simple vibration switches can detect the breaking through of a wall with hammers, chisels, drills and the like; sensitive seismic geophones can detect less obvious vibrations from cutting or burning through a wall or door; along with grid wires buried in or attached to the wall. The grid wire sensor has the advantage of being usable under noisy conditions as it only reacts to an actual breaking of the wire.

Simple vibration detectors may be attached to a wall at regular intervals; noisy activity or heavy vibration in adjacent areas may alarm the vibration sensors. Seismic sensors are more sensitive and cover a larger area but are more sensitive to vibration. They are best adapted for remote areas or after-hours application.

Audio microphones and passive ultrasonic sensors have the advantage that they can be installed away from the wall. Their positions must be properly chosen so that they can effectively monitor the entire threatened area.

The great majority (92%) of reported break-ins of buildings are not through the walls, but through the normal access opeings - doors and windows. Electrical devices are the most commonly used alarm means. The types of devices available are contact switches either mechanical or magnetic, vibration sensors, metal foil, photo electric light or IR sensors. Remote monitoring TV coupled with remotely activated door locks may be used to identify and provide access for authorized personnel to remotely located entrances.

High value cargo items may be placed in secure storage areas protected by the electrical devices described previously, or they may be protected by additional individual sensors. The individual sensors may be placed under, attached to, or in the vicinity of the high value items.

Pressure mats may be placed under the item so that its removal will be reported. Vibration sensors may be attached to the cargo. Also, capacitance type sensors may be attached; they will alarm when it is touched or closely approached. Items that are protected in this way must be insulated from the floor. Electromagnetic devices may also be placed on or in the vicinity of the cargo to be protected.

The use of physical barriers and electrical sensors as protective barriers will be ineffective unless provision is made for a rapid and adequate response to all reported incidents by the transportation security forces. A cost-effective alarm or monitoring system must be compatible with the electrical protection devices used and suitable for the response force available.

Most security systems utilize wires to connect the various detecting devices with the alarm receiving equipment. A short circuit, a broken wire, or other serious malfunctions would render the security system inoperative if not immediately detected. Therefore, a well-designed system will provide for automatically checking the circuits and actuating an emergency signal in the event of a failure. In addition, a well-designed security system must be tamper-proof in order to guard against someone compromising the wiring without causing an actual short circuit or broken connection. Security systems minus this feature can be jeopardized by expert intruders.

An alarm system should be modularly designed to provide the flexibility to accommodate the numbers and sizes of zones, the need for expansion, provide auxiliary monitor-display locations, and integrate the readout data from subsidiary systems into a common display . The design should be conservative to ensure that the system is stable, durable, reliable for long-lasting and continuous operation, and will require a minimum of maintenance and adjustment.

The Interagency Committee on Transportation Security developed an inventory of Government sponsored programs that could be useful for the physical security of cargo. The following summary is based upon the descriptions submitted by the Government Agencies involved with physical security programs.

The Defense Special Products Group is developing a Joint Services Interior Intrusion Detection System (J-SIIDS), which consists of a sensor system and control unit, a data transmission system, a local audible alarm, a monitor unit and a telephone dialer. The system is designed to detect the semi-skilled intruder who can be expected to attempt entry without detailed planning or sophisticated equipment. The Group is also developing a Modular Intrusion Detection System (BIDS) for military bases and installations. The system will interface with the J-SIIDS, and many commercial devices. The three major subsystems are the sensor family; transmission link; and monitor display.

The U.S. Army Land Warfare Laboratory (LWL), Aberdeen Proving Ground, Maryland, is testing a lightweight (20 lbs.) radar with an automatic alarm and with the capability of remote operation. This radar intrusion detector is applicable for the detection of intruders in terminal areas.

Similarly, the U.S. Air Force Systems Command is testing and evaluating a short-range, personnel detection radar to be used for search of airfields, railroad yards and terminal areas. The U.S. Air Force Systems Command is also testing and evaluating a fence disturbance sensor for railroad yards use.

The U.S. Army Mobility Equipment R&D Center (MERDC), Fort Belvoir, Virginia, has developed intrusion detection equipment for the protection of installations and interiors, including night observation devices. MERDC has developed an active infrared beam-breaker intrusion detector; an active beam-breaker infrared fence; a small, hand-emplaced, rapid assembly infrared intrusion detector for use in detecting infiltration across paths, perimeters, and other sites used in storage and other security applications. The system consists of an IR source module, an IR receiver/RF transmitter module, and a remote annunciator. MERDC has also developed an intrusion alarm annunciator as a small self-contained unit which renders audible tone and lock-up visual (lamp bulb) alarm indications upon receipt of signals along a telephone line, up to three miles from the line sensor intrusion detectors. Several thousand annunciators are in operation and have been successful. This organization has also developed an improved means of combining output signals from two intrusion detectors to reduce false alarm rates.

The specifications have been completed, and prototype action has been initiated, by MERDC for the following devices: (1) vibration sensor, (2) grid wire sensor, (3) balanced magnetic switch, (4) ultrasonic motion sensor, (5) passive ultrasonic sensor, (6) capacity proximity sensor, (7) magnetic weapon sensor, (8) fixed duress sensor, (9) portable duress sensor, (10) control unit, (11) local audible alarm, (12) telephone dialer, (13) data transmission system, and (14) monitor unit.

The LEAA Law Enforcement Standards Laboratory, National Bureau of Standards, Washington, D.C., has addressed itself to develop standards for an Area Security Alarm System. Since the optimum sensor array will be unique for a given environment, and since the environment cannot be standardized, their approach will be to develop a performance standard for each category of sensor, which will include a characterization of those environments which tend to degrade performance.

The types of sensors to be addressed have been categorized as: (1) electromechanical, which includes switches for doors and windows, foil for windows, protective wiring, and manual hold-up switches; (2) heat detectors for safes; (3) photoelectric devices; (4) vibration detectors; (5) audio detectors; (6) capacitance devcies which detect the proximity of a person; and (7) motion detection devices which detect motion by the Doppler shift technique. Even though the system being addressed is for a police department, the types of sensors and annunciator panels are the same equipment that could be utilized for cargo terminal areas.

The LEAA Standards Laboratory is also developing standards for area surveillance systems and equipment. The Surveillance Systems being addressed are those that assist in providing visual observation of an area, remotely or at the site, during daylight or night. These include night vision devices, such as low light level TV image intensifiers, portable and fixed; closed circuit TV; and the associated cameras and video tape recorders required to record evidence.

The U.S. Maritime Administration is evaluating a system which employs computerized controls to monitor and record container movements at port terminals and staging areas. The central computer can be programmed so that the containers cannot leave the terminal or be moved around the complex without warnings being sounded, unless the actual conforms to the routing instructions in the computer. The Automatic Container Identification method uses coded strips on each container passing through the terminal, which are "read" by optical scanning devices. The identification strips designate the container-type, serial number, and owner's name. This container identification system is adapted from a similar system developed by the Association of American Railroads for controlling mail car movement.

The U.S. Atomic Energy Commission has a facility for testing and qualifying security devices. The security devices or systems tested are: (1) intrusion equipment: (2) ultrasonics; (3) laser; (4) infrared; (5) light threshold detectors, (6) closed circuit TV alarm systems; (7) capacitor alarms; and (8) magnetic swithces.

## IV. PRODUCT PROTECTION FOR THE RAILCAR ENVIRONMENT

Although extensive data is available on the transportation environment, the information is generally scattered and fragmented. Detailed environmental information is required in order to minimize cargo damage in the hostile railcar environment. The following sections will assess the significant data currently available of the effects of the railcar environment on packaging.

The effects of impacts on packages are complex and misunderstood. Impact is defined in the "Shock and Vibration Handbook" as a single collision of one mass in motion with a second mass which may be either in motion or at rest. (Reference 1 ). Impacts to packages occur in a number of ways and cause a tremendous amount of damage to the contents.

Although most packages are designed to protect the product from dropping hazards, other types of impacts also occur in the distribution system. In the railcar environment, railcar switching produces impacts on packaging. These impacts vary in amplitude, waveshape, and duration, depending on the type of railcar cushioning device. The shock levels that result from the coupling impacts are primarily dependent on the car weight, impact velocity, and the shock absorbing system (draft gear) on the coupler. (The standard draft gear travels approximately four-and-one-half inches before bottoming, and the cushioned underframes or cushioning draft gear have a travel allowance up to thirty inches.)

One important difference between the impacts resulting when packages are dropped and the impacts resulting from railcar switching, is the duration of the impact. The impact from a switching operation may be of longer duration than the impacts received from dropping. At the moment when the ratio of the natural frequency of the packaged product to the frequency of the input shock is greater than 0.5, there is an amplification of the peak force. The problem that occurs in this situation is actually caused by the cushioning material that is used for protecting the product from drop impacts. With the drop impact, the cushion material reduces the peak acceleration of the impact to the product, and with some long duration railcar impacts, the cushioning materal amplifies the peak acceleration to the product.

Along with the number of different types of impacts that occur to packages, there are different kinds of shipping packages. There are those shipping containers that hold only one product, and there are those that contain a number of products in the same package, or multiple unit packages. The single unit type of package is much easier to analyze from an impact standpoint than the multiple unit package, because of the forces that develop from the interaction of the products inside the multiple packaging during impact.

The interaction problem is intensified at the time the shipping containers are placed into a transport vehicle such as a railcar. Once inside a railcar, there is the interaction between products and the interaction between packages. The single unit package then becomes much more complex to analyze because of this interaction of packages. Although one may have an understanding of his package outside the railcar, one must be aware that the characteristics of the package may change once it is placed inside the railcar. The packages will react differently when they are stacked upon each other because of the number of complex multiple degrees of freedom systems that exist. From a packaging viewpoint, little is known about the interaction forces between the packages inside transport vehicles.

The problem of protecting products for shipment may be approached from a damage sensitivity or fragility viewpoint. The damage boundary or damage sensitivity concept has been introduced, by a number of people, as the means to describe the shock sensitivity or fragility of products. This damage boundary concept is presented graphically as a plot of peak acceleration versus velocity change.

The derivation of a damage boundary is shown in Figure 1. The damage boundary was derived using a square wave shock pulse. The waveshape does affect the limiting acceleration boundary both in level and in shape. What the damage boundary concept underlines is that an impact has three important characteristics: (1) waveshape; (2) peak acceleration; and (3) velocity change.

The waveshape of the impact is important because of the response of a product to the varied waveshapes. That is, a square wave impact will cause a product to react differently than will a terminal sawtooth impact. Therefore, it is important to know the waveshape of the input impact to be able to design packages on a more scientific basis. (The theory and test procedure for damage boundaries is presented by Robert E. Newton in "Fragility Assessment Theory and Test Procedure". (Reference 2 .)

The peak acceleration is usually given as the only indicator of fragility. Yet, it has long been known that the duration of the acceleration is important in determining the severity of the shock. Therefore, the damage boundary concept informs one that the velocity change, which is the area under the acceleration - time curve, and peak acceleration together are a measure of the severity of a shock. From Figure 1, it can be seen that there must be sufficient velocity change along with sufficient acceleration to cause damage to a product. The damage boundaries for various products are graphed in Figure 2. The damage boundaries graphed for all six directions of a portable television are shown in Figure 3.

With the creation of the cushioned railcar, the transportation environment inside the vehicle has considerably changed. This environmental change is not being interpreted correctly. The shippers look to the cushioned car as a means to reduce the peak forces on their products without considering the ramifications of the cushioned impact, such as the longer duration and different waveshape. The impact duration is a very important consideration in package design. The short duration pulses, like those encoutered in the conventional railcar, are usually much less damaging than those impacts encountered in the 30-inch sliding sill cars. The short pulses are sometimes over before the product has time to react to them. The long pulses can be more damaging not only because of amplification, but also because of the time the forces are acting on the product.

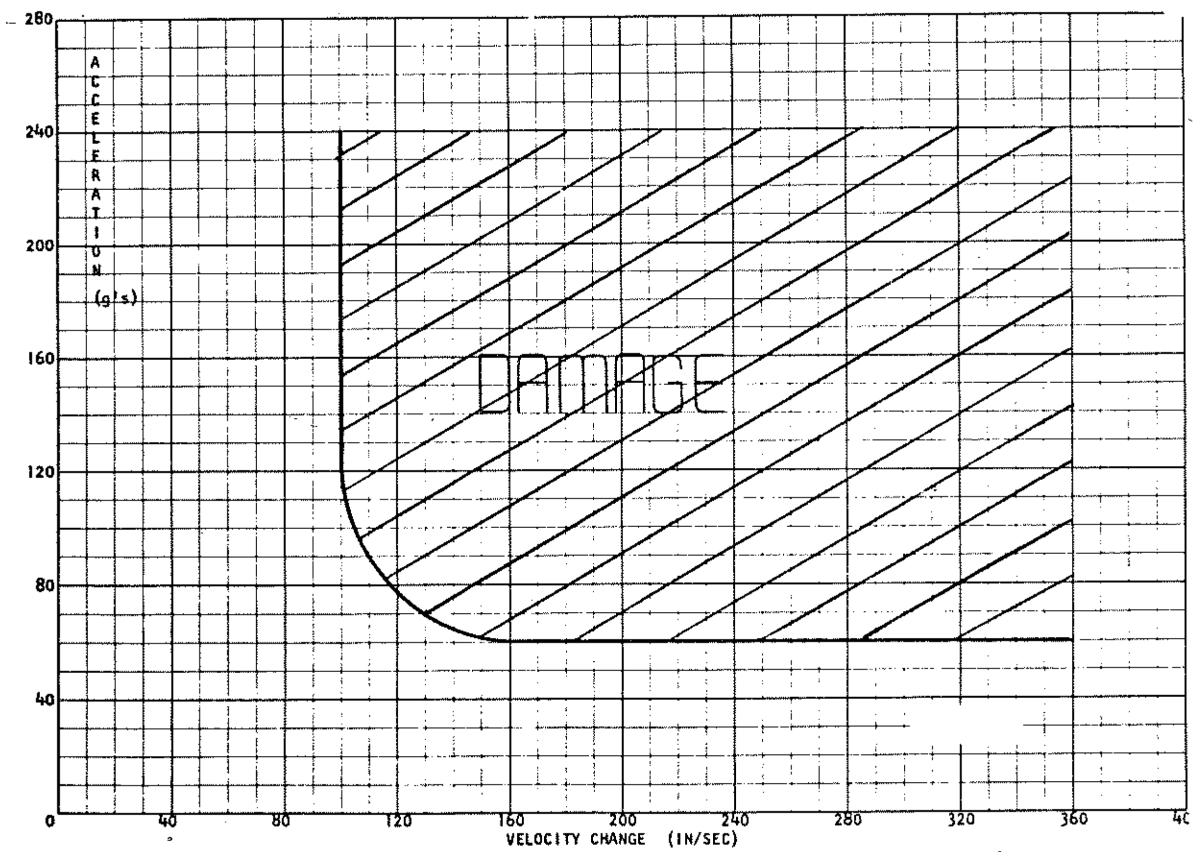



Fig.1 A damage boundary derived using square wave pulses

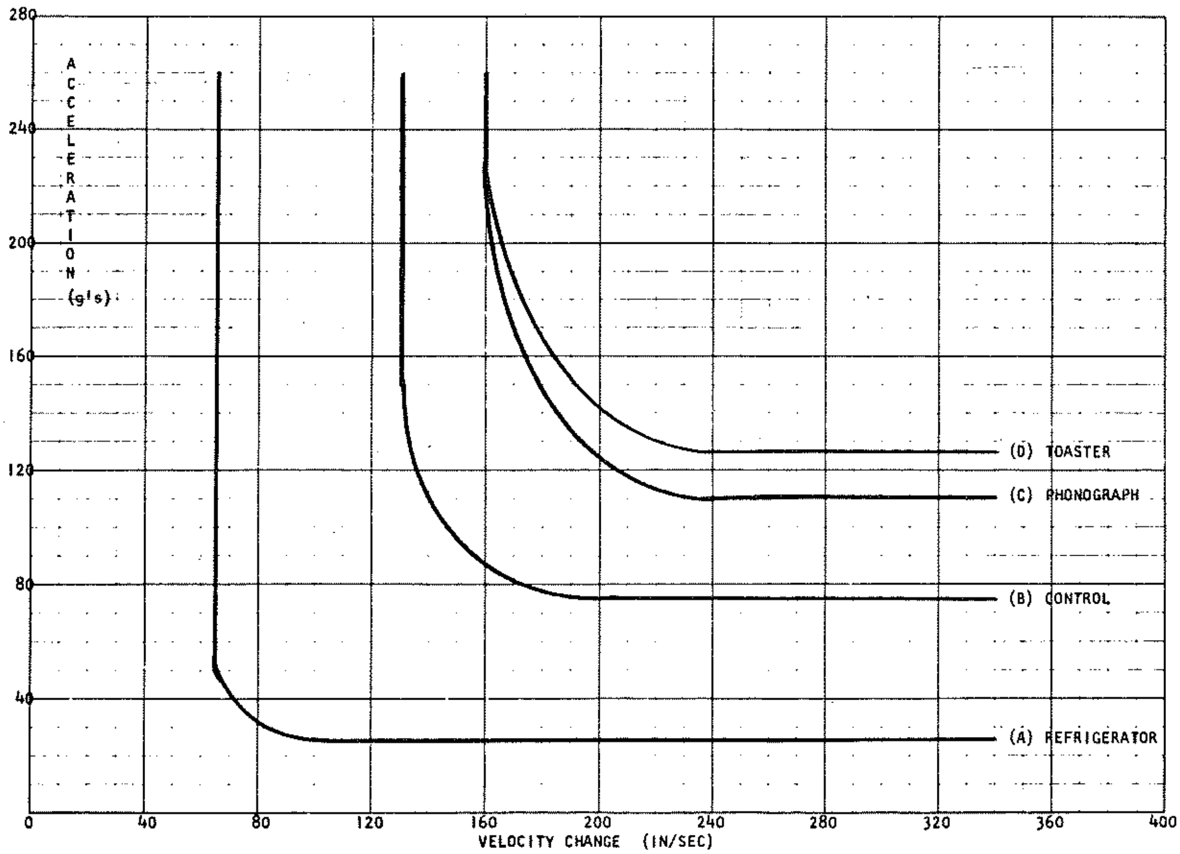



Fig.2 Damage boundaries for different products

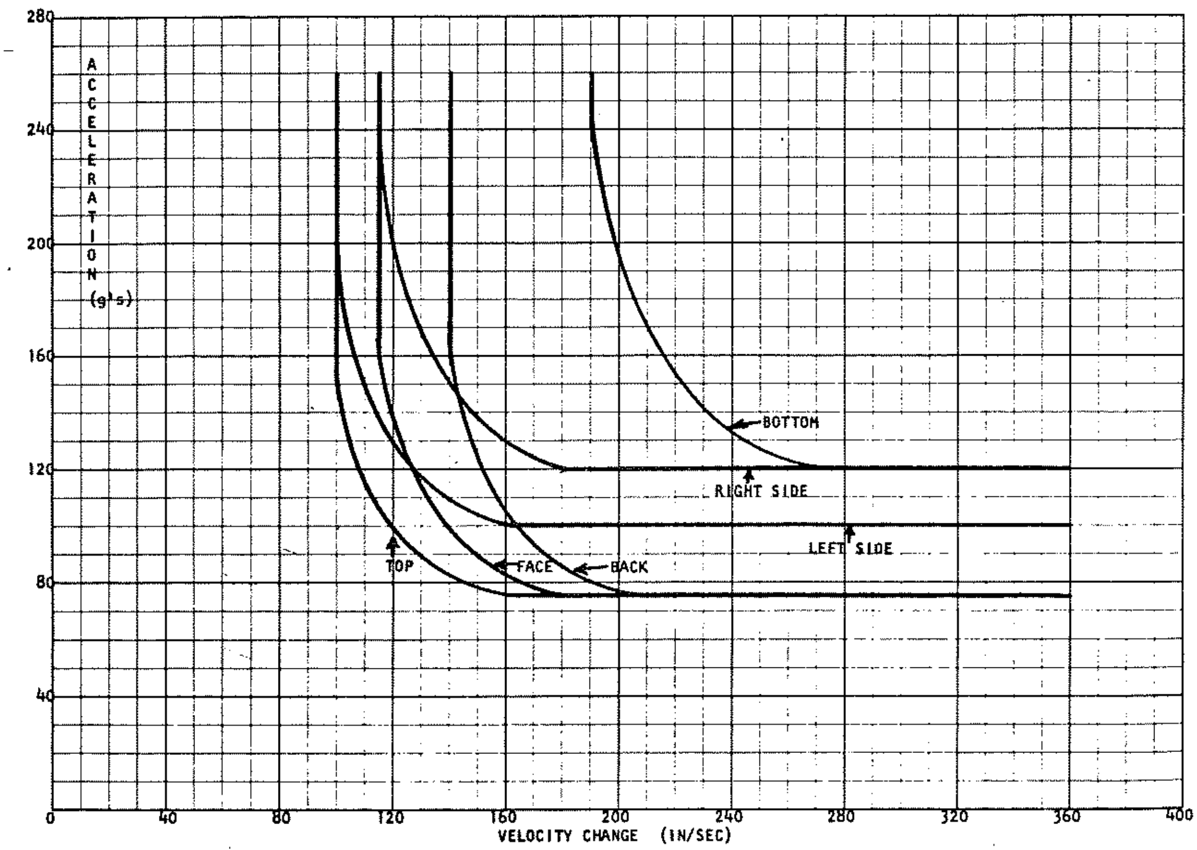


Fig.3 Damage boundaries for each direction of a portable television set

There are a number of problems to the package testing approach for the railcar environment. Some shippers will use such instruments as Impact Registers to measure the severity of an impact in a railcar. They then use these results to test their packages to the same severity on a Conbur Inclined Impact Tester. There are a number of problems with this approach to package testing for a rail environment. First, the Inclined Impact Tester was never designed to be used to simulate railcar switching operations. The duration of the input impact from a Conbur is usually very short (4 msec and less), and of a higher g-level than exists in the actual environment in railcars. Second, Impact Registers and other low-frequency measuring devices are very sensitive to the duration of an impact. Therefore, if one receives a zone 2 reading in a 20-inch sliding sill railcar, he cannot expect to reproduce the same severity impact on an Inclined Impact Tester when he measures zone 2 impact there. The problem is that the duration on the Inclined Impact Tester is much shorter than that in a 20-inch sliding sill car. If one is going to reproduce the same impact on the Conbur based on Impact Register type results, he must use the same duration shock pulse. In most cases, this is not done and erroneous results and future damage occur. There must be an understanding by the packaging community of the railcar impacts in order to successfully package their products for the transportation environment.

An apparently workable method for the development of a product protection system, based on hardware and established procedure, was implemented at the IBM Rochester, Minnesota facility to solve product damage in transit. The packaging program described indicates that the method maximizes the packaging engineers chances of deriving the ideal economic and protective package, the first time. Since this method was adopted, none of several thousand keyboards have been damaged in transit. The current cost of the packaging material and labor for this unit is significantly less than one percent of the unit value.

The elements of the product protection system consists of: (1) Product Design; (2) Fragility Data; (3) Environmental Data; (4) Engineering the Package; and (5) Package — Product Testing.

1. Product Design: the mechanical design concepts at this stage provide economic benefits when the product is later exposed to transit shock and vibration.

2. Fragility Data: within the constraints of a given mechanical design, it is necessary to assess the fragility of the product. Fragility is simply defined as the level of dynamic input required to cause minimal non-functionality in a product. A prior section emphasized the method of determining shock fragility based on the parameters of deceleration and total change in velocity. (Reference 3,4,5) The result of this empirical analysis is called damage boundary. Vibration fragility is specified by the natural frequencies of the product, with the emphasis on the lowest primary resonance. (Reference 6,7)

3. Environmental Data: although the general data is available, the specific techniques for application to product protection are conspicuous by their absence. Also, the forms of data reduction and presentation vary considerably. In general, the packaging engineers are not highly trained in dynamics, and thus there is a requirement for a straight forward set of environmental data that relates well to the empirical fragility data. A further constraint is that the environmental quantification be fairly easy to perform by the engineer.

4. Engineering the Package: the information on fragility and environment is combined with material data, along with packaging methods and processes, to engineer the product protection system or package. Some types of information necessary for designing the package are only now under development, and so the user must generate data for each application. Some of the most useful forms of data are given in Table 1 (References 8-13)

Table 1: Packaging Material Performance Data

| Data Type | X-axis Parameter | Y-axis Parameter |
|---|---|---|
| 1 | Percent Creep | Time |
| 2 | Static Stress | Response Deceleration |
| 3 | Static Stress | Natural Frequency |
| 4 | Forcing Frequency / Natural Frequency | Transmissibility |
| 5 | Strain | Stress |

5. Package-Product Testing: the product and its package are subjected to a series of tests to assess the ability of the package to protect the product during transit. The testing is an environmental simulation, with three basic types of inputs: (1) vibration, (2) horizontial shock inputs, and (3) vertical shock inputs.

Shock fragility testing is an equipment — dependent type operation. Although the literature suggests several alternate methods, the testing for the IBM application was performed on the Model 6060 MKII shock machine, manufactured by MTS Systems Corporation, Minneapolis, Minnesota. The resultant pulse used was a trapezoid wave shape (acceleration vs. time). The wave shapes significantly affect the test results, and thus the trapezoid wave is preferred, since it is the closest practical approach to the ideal rectangular wave (Reference 2 ). The vibration fragility is determined with an electrodynamic vibrator with a 500 pound vector force rating. The use of frequency sweeps and stroboscopic techniques identifies the lowest primary product resonance. The IBM environmental quantification program is based on the Transportation Environment Measuring and Recording System (TEMARS), manufactured by Endevco Corporation, Pasadena, California. TEMARS is a partable, battery-powered system that records shock inputs experienced in the transportation environment. The recordings are made on a seven track magnetic tape, using a non-return-to-zero recording mode called NRZI, to provide the compatibility with electronic data processing equipment.

A study conducted at the Forest Products Laboratory, in cooperation with the Fibre Box Association, investigated the effects of transportation vibration on the stacking loads which can be safely supported by corrugated containers. (Reference 14 ). Corrugated fiberboard containers are universally used for the packaging of a wide variety of products.

The Forest Products Laboratory used vibration transmissibility theory to analyze a vertical stack of loaded containers (a simplified spring-mass system with vibration excitation applied to the base of the stack). This experimental test program showed that the load — container systems were indeed frequency sensitive, and that the load a container could sustain was drastically reduced as the exciting frequency of vibration approached the calculated resonant frequency of the system. ("Unless you can measure what you are talking about, you know very little about the problem".)

The determination of realistic temperature limits that may occur in cargo transport, and the probability of the temperature extremes occurring, are difficult to decipher. As a result of the varying interdependent energy sources, and the great variability in the thermal response of the materials transported, the use of a computational scheme for predicting cargo temperatures would not be feasible. Rather, a simplified technique must be used, such as employing the data from various shipping and storage modes.

High temperature data for standing boxcars was collected at Yuma, Arizona, for a 119-day period. (Reference 15 .) The data from the boxcar storage test is presented in Table 2.

Table 2 - Boxcar Storage Test Results

| | Maximum Temperature, °F | Date |
|---|---|---|
| Top Center Carton | 119 | August 15 |
| Food | 113 | August 15 |
| Free Air Overall Maximum | 114 | August 17 |
| Free Air Mean Maximum | 102 | ________ |
| Free Air (30-Year) Record | 123 | ________ |

The cargo and air temperatures in an insulated boxcar, for a series of trips, are listed in Table 3. (Reference 16 .) While the data are incomplete, being the minimum temperatures are only recorded, the data does show a wide difference between the outside and inside air temperatures.

From the study of high temperatures in standing boxcars, in which the highest measured temperature was 119°F, the recommended maximum temperature duration for rail transportation is 120°F for two hours. The minimum temperature recommended is - 10°F for 36 hours. (Reference 15 .)

Table 3 - Air and Cargo Temperatures in Insulated Boxcar

| | Lowest temperature recorded, °F | | | |
|---|---|---|---|---|
| Destination | Outside of car | Inside of car | Inside full Carton | Inside Empty Carton |
| No. Kansas City | -2 | | | 32 |
| Kansas City | 25 | 44 | | 43 |
| Duluth | 26 | 40 | | 52 |
| No. Kansas City | 10 | 40 | 57 | 31 |
| Seattle | 12 | 40 | 52 | |
| Seattle | -10 | 29 | 52 | |
| No. Kansas City | 19 | 43 | 56 | |
| Seattle | -7 | 30 | 66 | |
| New Orleans | No Thermometers used | | | |
| Seattle | -8 | failed | 51 | |
| Rapid City | 8 | 31 | 56 | |

The Naval Weapons Center, in 1969, measured the temperatures experienced by truck transported ordnance during severe hot and cold weather conditions. (Reference 17 .) The conclusion derived from the tests was that the cargo reaches greater temperature extremes while the vehicle is stationary than while moving. This measurement series has shown that no piece of ordnance will be subjected to the extreme temperatures of the surrounding environment while being transported by truck.

During the cold-weather run, the lowest outside air temperature measured was - 20°F; however, the lowest ordnance temperature measured was - 3°F. During the hot-weather runs, the highest outside air temperature measured was 128°F; however, the highest ordnance temperature measured was 116°F.

In a recent study requested by the Whirlpool Corporation, the Association of American Railroads gathered information required to determine the causes for rail damage to housefold appliances, and to isolate the contributing conditions. The causes of the rail shipment damage to household appliances were identified as follows:

1. Lateral shift. . . . . . . .27% of all damage incidents
2. Pre-load handling. . . . .18% of all damage incidents
3. Protruding nails . . . . .17% of all damage incidents
4. Bracing not properly secured. . . . . . . . .11% of all damage incidents
5. Narrow gates . . . . . . . . 7% of all damage incidents
6. No doorway protection. . . 3% of all damage incidents
7. Unloading. . . . . . . . . . 3% of all damage incidents
8. Bracing not protected. . . 5% of all damage incidents
9. Bowed end walls. . . . . . . 1% of all damage incidents
10. Unknown. . . . . . . . . . . 8% of all damage incidents

There are five outstanding features which ultimately cause or create damage hazards. They are, as shown above, preload damage, material handling equipment, nails, bracing not properly applied, and side shift.

The contributing factors by the railroad industry to the appliance damage include the following: (1) poorly conditioned rail equipment; (2) rough car handling; and (3) lack of proper inspection and communication. It was noted that the carrier representatives or inspectors made only limited dockside inspections; and, for the most part, they were only car-door inspections. (Reference 18)

The amount of perishables moving through the retail grocery and institutional channels is about $60 billion at wholesale, which would indicate a retail value of over $80 billion. The annual perishables distribution bill is estimated at $16 billion. Transportation is the largest element, amounting to about 55 percent of the total distribution bill - around $8.5 to $9 billion. (Reference 19)

The U.S.D.A. has conducted research for many years on the transit requirements of perishable commodities. Their investigations are related to preserving the harvest — fresh quality of perishable agricultural commodities in this era of ever-increasing costs of production, distribution and marketing. Since time in transit may represent the largest part of the postharvest life of many perishable commodities, the railcar becomes a vital link in the distribution chain.

Considerable research has been conducted to develop better containers. The containers must protect the perishables, permit such heat exchange as required, serve as an appropriate merchandising unit, and have sufficient strength to withstand normal handling. The material, dimensions, and construction of containers shipped by rail, and the manner in which they may be loaded, are governed by the various freight container tariffs authorized by the Uniform Classification Committee. Despite these rules, heavy transit losses occur through careless packing, loading and unloading, improper load pattern, and rough car handling.

The weakening of fiberboard materials by moisture absorption, at the high humidities in refrigerated cars, is a serious problem. Many commodities are packed, almost exclusively, in fiberboard or corrugated cartons. The damage to contents may result from the collapse of such containers, particularly in the lower layers. This action also tends to block the channels required for proper air circulation. Further studies are being conducted by container manufacturers and the AAR Freight Loading and Container Section.

Mechanical cars equipped to handle the full range of both fresh and frozen commodities are designed to provide heat for the cold weather as well as refrigeration. A major feature of the mechanical car is in-transit thermostatic temperature control. The shipper has only to specify the temperature for his commodity. The change from cooling to heating, by means of electric heating elements or by reverse-cycle operation of the refrigerating unit, is done automatically by thermostatic controls.

The growth of the refrigerated piggyback or trailer-on-flatcar (TOFC) service has been even more spectacular than the mechanically refrigerated car. The TOFC fleet has already assumed a noteworthy share of the total perishable rail freight. The trailers may be loaded at any packing shed or storage place, and thus extend rail service to many shippers not located on a rail siding. To those receivers not located on rail sidings, the TOFC flexibility of providing door-to-door delivery at destination is an added advantage.

The primary job of the shipping container is to protect the product during the transit cycle-warehousing, transportation, and storage. The suitability and adequacy of the package are prescribed by the shippers' packaging engineers and the Uniform Classification Committee.

The condition of the package is a readily apparent fact. The damaged packages are in some way distorted from their original shape. The packaging conditions that describe these distortions are as follows:

(a) Wet: A package which is damp or moist, or is stained by contact with some type of liquid.

(b) Dirty: A package which is soiled or dusty. This condition has importance with food shipments.

(c) Dented, Bent, and Bulged: A dent is a hollow in surface made by a blow or by pressure. The bent shipping container is described as having been distored from a straight line. The bulge is a swell on one or more surfaces of the package.

(d) Creased: A crease is a fold or wrinkle in the package, with the appearance of a narrow line.

(e) Crushed, Racked: A package distorted by pressure (squeezed, crumpled or compressed). A racked package is distorted at the joints.

(f) Punctured, Gouged: A punctured package has been pierced by a sharp point. A gouge is a break in the surface, as if made by a scooping or chiseling action.

(g) Torn: A package which has been pulled apart or divided by force. This generally applies to fibre, paper, or flexible shipping containers.

(h) Deteriorated or Fatigued: A shipping container with loss of strength as indicated by bowed or creased surfaces, worn appearance, etc.

The packaging types, with their common failures, are listed in the following section:

1. Fibreboard Box: A package made of corrugated or solid fibreboard. Their common failures are: (a) the flaps do not meet squarely, (b) the flaps are open or loose (unsealed), (c) the package is too large or too small for the product, particularly the "head" space in the top of the package , (d) the package deteriorated due to prior handlings and lack of moisture control in storage areas.

2. Crate: A shipping container made principally of wood; may be wire bound; the closure may be with nails, straps, wire, or staples. Their common failures are: (a) failure to use diagonals, (b) failure to apply diagonals properly, and (c) failure to obtain an adequate closure (loose nails, staples, etc.).

3. Drums, Barrels, and Pails - Metal, Plastic, Fibre, and Wood: A shipping container that is cylindrical in shape. Their common failures are:

Metal:

(a) improper sealing at the body seal or where the top is applied to the body.

(b) failure to obtain complete, even-lid closure.

(c) leakage due to chines (bottom lip) being worn from repeated use.

Plastic:

(a) brittleness in extreme cold.

(b) failure to obtain complete, even-lid closure (in general, the application of a metal lid to a plastic body).

Fibre:

(a) seam failure where metal rim joins fibre body.

(b) failure to obtain complete, even-lid closure.

Wood:

(a) bung stave broken.

(b) metal hoops loose, allowing staves to spread.

(c) leaking from seams

4. Bags - Textile, Paper, and Plastic: A flexible container, seamed lengthwise and sealed at both ends. Their common failures are:

| | |
|---|---|
| Textile: | stitching uneven, insufficient, applied to close to the end, resulting in poor closure. |
| Paper: | Gluing or stitching uneven, insuffcient, applied to close to the end, resulting in poor closure. |
| Plastic: | Dirt particles (lack of cleanliness) in the heat seal, resulting in poor closure. |

5. Wrapped: flexible packaging material, generally paper, applied around a product and secured with cord, wire, banding, adhesive, etc. The common failures are: (a) loose wrapping resulting in poor closure, and (b) loose ties, rope, bands, wire, etc., resulting in poor closure.

6. Bundles: several pieces of lading bound together by straps, wire, cord, etc. The common failures are: (a) settling of the product to cause the ties to loosen, and (b) application of insufficient bundling material.

Loading is the physical act of placing and positioning freight inside the railcar or trailer. Many loading methods and patterns have been designed and implemented. The aim of any loading method is: (a) to best utilize the space available; (b) to arrange and position the cargo so as to avoid damage where pieces contact one another, the vehicle, or the bracing; and (c) to arrange and position the cargo in a manner which will best absorb or spread the forces encountered during transit.

Nearly all loading patterns or methods are subject to three very common failures: (a) lengthwise and/or crosswise voids, (b) loose loading, and (c) no divider sheets.

1. Voids: the loading pattern or method should strive to make use of all possible space in the rail vehicle, leaving little or no void areas. (When it is not possible to devise a pattern or method which will eliminate voids, bracing is applied to restrain the load away from the void area.) Void areas next to the cargo permit load movement; and load movement, more often than not results in damaging contacts among cargo items, and between the cargo and vehicle.

2. Loose Loading: the failure to load tightly, one piece of cargo snugly against the other, lengthwise and crosswise, can ultimately result in void spaces appearing in the load.

3. Divider Sheets: the failure to use divider sheets at appropriate points in the load can permit damaging contacts between cargo and bracing, and among cargo items. The need for divider sheets should be provided at points of contact between different size packages or units, between upper and lower layers in some loads, between bracing and cargo at hazardous contact points, and between cargo and equipment in certain situations.

The Association of American Railroads Circular No. 42-D, "General Rules Covering Loading of Carload Shipments of Commodities in Closed Cars" provides the "general rules" which must be observed for all closed carloading. These general rules take precedence over the rules and recommendations in specific commodity Loading Pamphlets. They are prescribed for the safe operation of the railroad, and compliance is mandatory for rail vehicles interchanged between rail carriers.

Circular 42-D details six basis rules which were formulated for the purpose of providing safe methods of loading in closed cars and which must be observed:

Rule 1 - Inspection and Selection of Cars
Rule 2 - Clearance - Side Bearing - Loading Cars
Rule 3 - Maximum Load Weight - Crosswise of Car
Rule 4 - Distribution of Weight - Crosswise of Car
Rule 5 - Loading, Blocking, and Bracing
Rule 6 - Doorway Protection

Bracing is simply a means of restraining, retaining, and/or containing the cargo in its original loaded position to prevent unintentional cargo movement during transit. The purpose of the bracing is, then, the following: (a) restrains unintentional cargo movement, (b) retains the cargo in place and away from unfilled void areas, and (c) contains the cargo in the units dictated by the loading pattern.

The Bracing may be divided into the following functions:

1. Floor Bracing: to prevent movement of cargo lengthwise and/or crosswise on the car floor.

2. Cross Car Bracing: to prevent lengthwise movement of the cargo in all layers, stacks, and rows.

3. Center of Side Bracing: to prevent crosswise movement of the cargo in all layers, stacks, and rows.

4. Doorway Bracing: to prevent cargo from moving against the doors of the vehicle.

5. Dividers: to prevent portions of the cargo from moving into one another; particularly to divide stacks of different types or sizes of product, or to divide layers.

6. Bulkheads: to separate or compartmentalize separate portions of the cargo in order to reduce the flow of force through the load, as well as to separate product by size, type, etc. Bulkheads may also be used as dividers.

7. Incomplete Layer Bracing: to prevent movement of incomplete layers lengthwise or crosswise in the vehicle.

Load movement is not a cause of damage, it is rather an indication of a failure in the transportation environment. Factual information about load movement will often help diagnose or expose transportation and handling failures. (Ref. 20-27)

The forces necessary to move a load from its original position within the rail vehicle may be divided into three categories:

1. Longitudinal forces - are created primarily during acceleration and deceleration, and particularly during the coupling operation.

2. Lateral forces - are created by the sideways rocking motion of the railcar and its movement on curves.

3. Vertical forces - are created basically by the motion of the car over the roadbed and by the design of the car, particularly the springs.

The effects of longitudinal forces can be seen when the lading has moved lengthwise in the rail vehicle. The effects of the lateral forces can be seen when the cargo has shifted sideways in the vehicle. Vertical forces alone do not generally create effects which can be readily seen, but in conjunction with longitudinal or lateral forces, the cargo indicates a "walking" or "spreading" movement. The unleashing of these forces creates the damaging load movement.

## V. CONCEPTS IN FREIGHT CAR CUSIONING AND LADING PROTECTION

In the early days of railroading, the primary concern of the railroad was the effect of shocks on the car structure. The scope of this concern gradually grew as the freight became more sophisticated and the damage to the lading became more costly.

The concepts in freight car cushioning emphasize the protection given to the lading and car structure when the longitudinal impact forces are applied. These cushioning devices are designed to control the longitudinal forces developed from the impacts occurring when railcars are classified or coupled, and from the high forces developed through slack action in the cars.

Many considerations involving engineering, railroad operation, and economics govern the design of the shock absorber devices. Draft gears and cushion underframes are shock absorbing devices designed to receive coupler forces and to dissipate them without damage to the car structure and lading. With the increase in car weights, and with switching and train impacts becoming more severe, the need to enhance the lading protection, both in transit and in-yard operations, led to the development and use of friction-rubber, all-rubber, and hydraulic draft gears. Concurrent with the development of higher capacity draft gears was the introduction of hydraulic devices for use in cushioned underframes and end-of-car cushioning. These special cushioning units dissipate considerable energy through a combination of travel and hydraulic and frictional resistance.

For many years the Association for American Railroads (AAR) standard for draft gear was 18,000 ft-lb. capacity measured at a point just before the draft gear closed. Many gears, approved under this specification, remain in service. But with the present day requirements for railcars of seventy-seven tons capacity and larger, the new standards for draft gear require a minimum capcity of 36,000 ft-lb., with a reaction force not to exceed 500,000-lb. as measured under the AAR 27,000-lb. drop hammer. The relationship of capacity to reaction force is a realistic requirement since the car structure and the lading must absorb the energy inputs through the build-up of reaction forces as the impact forces are applied to the car. The capacity of draft gear is defined as the foot-pounds of energy input or kinetic energy input required to close the gear or produce the rated or recommended travel of the gear. This capacity is usually taken as the ability of the gear to absorb impact shocks with a minimum reaction force, so as to protect the railcar structure and its cargo. Extensive evaluations have been performed on these devices to study the relationship between the force of impact and the transmission of force to the car body and the lading.

With the development of cushioned underframes and end-of car cushioning for freight cars, the need for detailed information on the performance of these units, when subjected to longitudinal impact forces, was apparent. The first comprehensive tests were conducted jointly in 1962-63, by the Pennsylvania Railroad (PRR) and the AAR Research Department. The studies were designed to determine the relative characteristics of special cushioning devices relating to travel, energy absorption, and the protection provided to the car and lading.

The boxcar, with the varied cushioning devices, was loaded with either canned goods to represent a resilent type of loading or with steel boxes filled with cropped rail to represent a rigid type of load. (Blocking and bracing were used as required.) Accelerometers, both mechanical and electronic, were secured to the lading. The accelerometers were to provide information on the force frequency inputs to the loads. The boxcar underframe was also equipped with accelerometers. The standing car was provided with dynamometer couplers to measure the coupler force.

The joint AAR-PRR impact study highlighted the fact that the sliding sill-type cars provided the most protection to the lading through the reduction of forces transmitted to the car lading. The study also determined that the hydraulic type end-of-car cushioning device provided superior protection to the underframe structure when the test car was impacted in the dynamic squeeze condition. (The impacting or moving car produced a dynamic squeeze action on the boxcar equipped with the cushioning device.)

The results from the joint study was the basis for the specification covering special cushioning devices. The specification requires that a railcar equipped with a cushioning device be subjected to free-to-roll impact tests and dynamic squeeze tests, in addition to a test to investigate the strength of the underframe components at the end of the car. With the free-to-roll test, the railcar is impacted in small speed increments until a coupler reaction force of 500,000-lb. is measured or an impact speed of fourteen mph is reached (whichever occurs first). The rating capacity of the car is that speed where the 500,000-lb. reaction force is developed. The dynamic squeeze test is utilized to study the underframe and cushioning structural strength; the tests are performed at speeds to fourteen mph or to a coupler force of 1250 K-lb. The test car is loaded with concrete blocks to the load limit of a 77-ton car, providing a rigid and reproducable load.

From the results of these studies at the AAR Research Center, fifteen special cusioning devices have been AAR-certified. The evolution of new cushioning systems to provide for a railcar and its lading is continuing. The higher capacity cushioning systems are receiving increased attention in an attempt to reduce the lading damage costs and to improve the car protection.

In this decade, the railroads are experiencing a continuing increase in the average weight of cars in freight trains due to the large number of high-capacity cars which have entered the freight-car fleet. There are over 500,000 cars, approximately 28 percent of the fleet, that weigh more than 100 tons at capacity load. And, concurrently, there is the mounting pressure to increase train speeds, as well as to speed-up the handling of cars at the marshalling yards. This tendency to increase the overall productivity of the railroad plant has increased the probability of railcars receiving high-speed impacts, with the resultant rise in claims and customer dissatisfaction. As a consequence, the use of freight-car cushioning equipment has been enlarged over the years. The reduction in the railroad's loss and

and damage bill is an absolute necessity if the railroads are to improve their economic postion, their service, and their customers' satisfaction.

Freight-car cushioning equipment has been exhaustively tested in yards, in special impact testing facilities by such agencies as the AAR, the railroads and the railroad supply industry. These tests always confirm the fact that these devices do reduce the impact forces to the lading carried in the railcar. With the lading protected by these devices, why does the railroad industry loss and damage bill continue to climb, even with the wide application of the well-proven cushioning units? And, as the damage bill continues to climb, of what value are these expensive cushioning units to the railroad and shipping constituency?

This type of questioning provokes the more detailed evaluation of freight-car cushioning effectiveness as measured by service experience. The Baltimore and Ohio Railraod initiated such a study, with a basic objective to develop comparative loss and damage performance data between cushioned and uncushioned railcars, and to discover the differential performance of the various types of cushioning equipment. In order for the evaluation results to be reliable, evaluated criteria were used to eliminate or greatly reduce the data bias, and it may be concluded that the evaluation of the cushion underframe performance was not distorted nor unduly affected by differences in such major factors as car utilization, commodity value, commodity susceptibility to damage, shipper handling and packaging practices, yard terminal switching and car handling practices, track conditions or the terrain.

Based on the B & O findings, the following conclusions may be made:

(a) Cushioned cars account for lower claim costs than cars with standard draft gear and interior equipment.

(b) The maximum reductions occur with cars having 30-inch travel cushioning. The reduction averaged about $84 per car per year lower than the non-cushioned cars.

(c) This reduction is insufficient to justify the application of cushioning units to all cars.

(d) The cushioning equipment performance begins to deteriorate after the fourth or fifth year of service.

(e) The cushioned cars have their place in the freight-car fleet for special services especially with fragile commodities. The railroads, shippers and suppliers must cooperate in selecting their application for a maximum reduction in loss and damage. (Reference 1a).

The character and makeup of the freight car fleet has undergone change in the past decade. These changes include an increase in normal car capacity from 50 to 70 tons, the availability of various primary spring rates, variable-rate or "constant frequency" springs, and new freight-car truck suspension systems, which depart significantly from the present AAR standard designs. In order to accurately define the freight car vibration environment with present day boxcar equipment, the Federal Railroad Administration and the C & O Railway entered into a joint project, in 1969, to develop the detailed data. (Reference 1)

The evaluation program consisted of the effects of load, speed and track input; friction damping levels; primary spring rates; variable rate springs; truck design; and flat wheels on the vibration environment within the test boxcar and the trucks. The most important factor to be considered in evaluating the vibration environment is the vibrational power that the track transfers to the truck and hence to the car body.

The test boxcar was a 50-foot, 70-ton boxcar, as was the "control car". To develop the effect of load on the environment, the load in the test boxcar was varied from empty, to half-load, and to full-load. The load in the "control car" was constant at 35-tons. The instrumentation used to define the vibration environment were vertical and lateral accelerometers mounted on the truck side frame over the roller bearing adapter and on the test boxcar floor over the center plate.

The conclusions derived from the C & O study were as follows:

(a) The vibration environment within a freight car body is comprised of vibrational energy at all frequencies between 1.5 and 520 $H_z$ (the maximum frequency evaluated). This vibrational energy is concentrated in the forcing frequency range of 1 to 10 $H_z$ and in the 2 wave bending mode of the car body, which in this case was centered at 80 $H_z$. Other car designs would yield other car body bending mode frequencies.

(b) The vibration energy within the freight car truck is concentrated at the natural frequencies of the wheel-on-rail and of the track structure, and at the wheel forcing frequency for other than round wheels.

(c) An increase in load decreases the vibration levels in the car body and increases the vibration level in the trucks.

(d) An increase in speed causes an exponential increase in the vibration levels in both the car body and the trucks.

(e) An increase in track irregularity causes an exponential increase in the vibration levels in both the car body and the trucks.

(f) Flat wheels cause an increase in the vibration levels in the car body and an extreme increase in truck vibration levels.

(g) A decrease in damping level from normal increases the "rigid" car body vibration level, decreases the car body bending mode and truck vibration levels.

(h) An increase in the damping level from normal causes little change in the "rigid" car body vibration level except at resonance, but increases the car body bending mode and truck vibration levels.

(i) An increase in primary spring travel (i.e., a reduction in spring rate) reduces the "rigid" car body, car body bending mode, and truck vibration levels.

(j) Variable rate springs provide a constant "rigid" car body natural frequency regardless of load, but may cause a small increase in the "rigid" car body vibration power levels.

(k) Springs over the journal bearings, rubber bonded double bolsters, long travel springs, and rubber bearing adapters significantly reduce the car body vibration levels.

The dyanmic environment encountered by cargo during rail transportation has been measured, estimated, and discussed for many years. There has been general agreement on the severity of the humping or coupling shock event.

The gravity type of switching used in most large terminals is called hump switching. A hump is built up so that the yard slopes upward from each end toward the center. The hump is built on a one percent grade up which the cars are pushed to the top of the hump. The cars then roll under the influence of gravity downgrade to the classification tracks, being guided to the proper track by remote control switching operated from the central control tower. A number of major gravity type (hump) yards have been completely or partially automated in an effort to better control and limit the coupling impact speeds during switching and classifying procedures.

The results of the most recent AAR survey on impact speeds indicates the average impact coupling speed at six mph. The railroad axiom is that impacts of four mph or lower are "safe" (little or no lading damage), whereas impacts above this speed cause considerable damage. The damage increases, approximately, as the square of the impact speed. (A 7 mph impact is almost twice as damaging as an impact at 5 mph.) This means that more than 80 percent of all the impacts are potentially damage-causing. Figure 1 provides an insight to the problem.

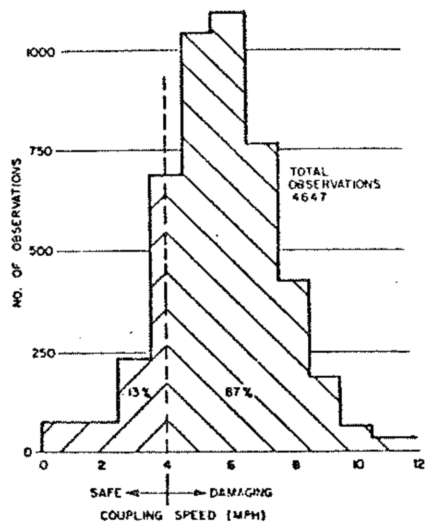



Fig.1 A.A.R. field observations

Association of American Railroads; Mechanical Division, Report of Committee on Couplers and Draft Gear, Circular No. DV1594, May 24, 1965.

With the damage claims nearing catastrophic amounts and a major portion resulting from high switching speeds, it appears highly desirable that there be a more enlightened understanding of railcar impacts - the factors involved and the clarification of such terms as force, velocity, acceleration, kinetic energy, work, capacity, absorption and recoil. There should also be additional understanding of how a hydraulic unit cushions the impact, or even the desirability of the hydraulic unit.

The functions of a cushioning unit are not complex, but their requirements are exacting. The cushioning device is designed for the storing and transforming of energy, and it must do its work over a reasonably long period between inspections and adjustments, with limits of time and distance through which it may act, and the space it may occupy. There are numberous parameters that must be fulfilled before any cushioning device can be classified as meeting current requirements for railcar service. The cushioning device must have adequate absorption capacity; excessive peak forces must not be transmitted to the car structure and lading; recoil action must be minimized or eliminated so that the energy stored in the absorption system is not reversed in the form of a violent aftershock; uncontrolled slack must be avoided so as not to complicate train handling; the device must withstand abuses common to freight-car service, with easily installed interchangeable components; the cost must not be prohibitive; and the shock absorbing characteristics of the cushioning device must be predictable and consistent (if possible, the response mechanism should be adjustable to accommodate the service conditions.)

The development of a device which will reduce the forces generated by the impact of large masses at high velocities is needed. This could take the form of a hydraulic unit with special operating capabilities and design simplicity. The cushion underframe bearing no similarity to the draft gear which it would replace, and eliminating the restrictions that rigid standards have imposed, should be pursued.

The designation TOFC and COFC refer to trailers-on-flat-cars and containers-on-flat-cars. As the shipment of trailers and containers by rail continues to increase, the cushion arrangements for lading protection during impact increases in importance. With the initiation of "piggyback" operations, such cars were given special handling and were not subjected to the normal switchyard humping. However, as the shipments of trailers and containers continues to increase, the tendency is growing not to provide that special handling, and eventually to attain a complete "mixed car" service through hump yards. For these reasons, the cushion arrangements to provide lading protection during severe impacts are of growing importance. The industry should resolve these questions soon, since there are several TOFC and COFC systems being used and many more being developed.

The Pullman-Standard tests for TOFC - COFC arrangements in yard-type impact tests has not progressed enough to be conclusive. At present, it appears that the on-deck cushioning is more effective for a given travel than the car-body cushioning. With present day considerations of TOFC and COFC operations, TOFC is the primary consideration and can best be served by on-deck cushioned stands, such as the 12-inch travel, shear rubber, pull-up stand. Until the ultimate TOFC - COFC arrangement is established, the standard draft gear car should provide the base for today's equipment. This same car with vastly improved on-deck cushioning arrangements may provide adequate lading protection for the future. (Reference 2).

An appraisal of responsible rail officials indicates an awareness and justification for major design changes in freight-car equipment to counteract the high costs presently resulting from the lading damaged in transit. In return for the freedom to equate rates with service and some monetary encouragement, the railroads would conduct research for a better car with new braking and coupling systems; faster switching with less labor; and a longer reliable car life. The railroads would also initiate work on a new control system for routing cars.

## VI. CONCLUSIONS AND RECOMMENDATIONS

Additional information is required to more accurately define the environmental conditions encountered by the cargo during transportation. The accumulation of new data is required especially for such new equipment as trailers-on-flatcars (TOFC) and containers-on-flatcars (COFC); the high speed railcars; and the 40-foot containers. This information could significantly alter the description of the environmental conditions encountered by the cargo, and should therefore be incorporated into the previously developed concepts. Significant cost savings should be realized through the generation and utilization of this new data.

There is the additional need for newly-developed laboratory simulation tests for the transportation and handling environments. For example, an inproved test is required to simulate the railroad humping shocks.

There is minimal knowledge about the interaction forces between packages inside the transport vehicle. Techniques are required to measure the shock and vibration environment encountered by unrestrained or loose cargo, and then to translate this new environmental data into improved laboratory tests.

There are organizations and agencies already equipped to gather specific information for the various modes of transportation. Specifically, the U.S. Army Natick Laboratories, the AEC/Sandia Laboratories, the Packaging School of Michigan State University, the Association of American Railroads, and the Naval Ordnance Laboratory at China Lake, California.

Many of the data gaps could be more readily identified by the initiation of a national symposium. A Freight Loss and Damage symposium should be concerned with current definitions to include the following:

1. The Rail Transport Environment
2. The Application of Transportation Shock and Vibration Data to Package Design
3. The Measurement and Protective Systems for the Transportation Environment
4. Up-dated Specifications for Freight Car Design
5. Current Energy Absorbing and Impact Attenuation Systems
6. Normal and Abnormal Dynamic Environments Encountered in Truck Transportation
7. The Development of a Product Protection System to Prevent Shock Damage
8. Containerization
9. Environmental Protection for Climatic Extremes
10. Cargo Loss

## RECOMMENDED ENGINEERING PROGRAMS

### 1. Product Protection System

Packaging design for the purpose of limiting shipping damage has long been an engineering problem of economic importance. The new methodology being generated for the development of a Product Protection System for the damaged goods problem appears promising and should be actively pursued. The Product Protection System maximizes the designer's ability to produce the ideal economic and protective package to cope with the transportation environment. For the development of a Product Protection System it becomes necessary to assess the fragility of the product. Recent literature has emphasized a method of determine shock fragility specifications based on deceleration and total change in velocity. The result of this empirical analysis is called a damage boundary; a damage boundary for a particular product is a two-dimensional plot of shock against velocity change. A damage boundary procedure has been developed and applied to diverse products. This procedure has produced, on a repeatable basis, the precise reproduction of transportation damage. The damage boundary, when available, provides the packaging engineer with the method for submitting the ideal economic and protective package for limiting shipping damage.

Cargo-Handling Environment

The severest shock environment encountered by cargo occurs during the handling operations. Data are insufficient at present to accurately describe the handling shock environment for any given package and distribution system. The engineering personnel in packaging and testing require the detailed information describing these effects. The current instrument development programs should provide an excellent source for cargo-handling measurement programs.

The development of a Product Protection System, for the in-transit and handling environments, appears to have the greatest immediate potential for dramatically controlling the railcar damaged goods problem.

2. Freight Car Cushioning Systems

There is an apparent need for more exact methods to evaluate the various cushioning systems. The testing effort has provided limited data in terms of the effect of the cushioning equipment on cargo transported in railcars.

In order to reduce the lading damage costs and improve railcar protection, higher capacity cushioning systems should receive increased attention. The further evaluation of railcar cushioning systems requires the examination of the recoil and energy absorbing characteristics of draft gear; the design concepts for draft gear; and the detailed examination of the performance tests of hydraulic devices in long travel cushion underframes and end-of-car cushioning; and the test techniques for special cushioning devices. The characteristics and influence of the cushioning on railcar action, along with the data to more accurately define the railcar vibration environment, should be further investigated.

Impact Studies

New criteria are required for judging the performance of freight cars during impact. The work completed on special cushioning devices, load restraint, car forces, and accelerations developed in loads serves only as background for the information ideally required to evaluate the impact environment of a freight car and its lading.

Such new impact criteria as the design data for overspeed impacts; the relationship between peak coupler force and peak end-wall lading force; the instrumentation required to measure impact speed, coupler and bulkhead forces; and yard-impact simulation models for various types of lading should be forthcoming.

TOFC-COFC Cushioning Systems

The cushion arrangements to provide protection for the TOFC-COFC lading during impact are of growing importance. The variety of TOFC-COFC cushioning arrangements available for handling piggyback and container cars indicates the need to evaluate the comparative test data for determining the cushion effectiveness or limitations of the various cushioning systems. The evaluation of the various cushioning systems would also contribute to the design standards required for the rail flatcar that interchangeably transport cargo containers and highway trailers.

3. Railroad Cargo Security Programs

With the tremendous number and variety of intrusion detection equipment and physical barriers available for cargo security purposes, it is recommended that a cargo security system design be identified from the equipment utilized by Government agencies or the equipment tested under Government auspices. The actual system design of the intrusion detection equipment must be detailed for the individual installation, since the physical protection barriers and the electrical detection system must be compatible.

## GLOSSARY

Forcing Frequencies---The range of vibration frequencies caused by track or wheel roughness. These are generally between 0 and 10 Hz and are speed dependent.

Spring Travel---The distance through which a freight car truck spring will compress between empty car weight and fully loaded weight.

"Rigid" Car Vibrations---The vibration of an infinitely stiff car body on the suspension system springs.

1-Wave Car body Bending---The flexure of the car body as a single wave.

2-Wave Car Body Bending---The second harmonic of the 1-wave car body bending mode.

"Rock Off" test track---A section of track 20 rail lengths long with every joint having a depression of 3/4 inches from level. It is used to develop a harmonic roll input to cars having high centers of gravity.

"Rock and Roll"---The resonant roll characteristics of high center of gravity cars which make them susceptible to derailment.

Snubbing---The friction damping mechanisms installed infreight car trucks.

Variable Rate Spring---A spring with a nonlinear load deflection curve which maintains a constant natural frequency regardless of the load in the car.

Natural Frequency---The frequency at which the car body will vibrate on the suspension system springs after the body has been displaced from its equilibrium position.

Resonance---The condition where in the forcing frequency input to the suspension system equals the natural frequency of the system. At resonance, the suspension system amplification of the forcing input reaches a maximum.

Critical Speed---The speed at which suspension system resonance occurs with track induced inputs.

Damping---Means to absorb vibration energy in the system.

Critical Damping---Amount of damping at which no vibration occurs after the spring mass has been displaced from equilibrium position.

Vertical Vibration---Pure up and down motion often described as bounce.

Lateral Vibration---Pure side to side movement in the horizontal plane.

Pitch---Angular motion in the vertical plane about the axle perpendicular to the direction of the track.

Yaw---Angular motion in the horizontal plane about a vertical axis.

Nosing----A special case of Yaw usually describing a motion of a locomotive which applies lateral forces alternately on the right and left rails of the track.

Fishtailing---- Another special case of Yaw describing the motion of the rear-end lateral motion of the vehicle about the front truck as a center.

Hunting---Oscillation alternately to each side of central point,of to run faster and slower instead of steadily because of insufficient stability controls. (This term is often used to describe the movement of an axle set on the track as caused by connicity of the wheels).

Harmonius Roll---Angular displacement of the vehicle body about its longitudinal axis. This has been referred to as Rock & Roll.

Swiveling---Angular Oscillation about an axis;a symmetry, usually applied to truck action when the bolster oscillates around the center-pin.

Shimmy---A self exciting vibration of the truck, producing swiveling of the truck and resulting in hunting of the truck on the track and Yaw movement of the car-body. This refers to 2.5-3.5cps. vibration frequency.

Rail Overturning---While this is not a car or truck motion term, it should be applied only when there is conclusive evidence of excessively high lateral forces generated by the rail vehicle involved.

Tram---This term applies to the diagonal measurement of axle bearing locations. When, in a four wheel truck the two diagonal measurements are equal, the truck is said to be in tram.

Walking---This term describes the vertical equalization and flexibility of a truck. Trucks are required to negotiate rough track conditions which demand that each wheel follow the rail head with minimum tendency to unload. Proper equalization is implied and sufficient mechanical freedom to permit independent rise and fall is necessary. When a truck meets these requirements, it is said to "walk" freely on rough track without derailing or unloading of any of its wheels.

Wheel Climb---This term applies to the condition where the lateral (axial) force between the wheel flange and rail head is great enough so that the resulting friction force causes the wheel flange to climb up on the rail.

Wheel Lift---This term applies to the lifting of a lightly loaded wheel due to high veritical force on the opposite bearing and the resulting moment. Such forces are encountered when rail vehicles are operated at speeds too great for the existing super-elevation on a curve, from high draft (or buff) forces on a curve, from harmonius rocking of a car on rough track, or from very slow speed operation on a high super-elevation curve.

Swing Motion---This term is applied to vehicle suspension systems where lateral motion is accommodated by the use of mechanical linkage means. Example: Swing hangers.

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