SOME PRINCIPLES OF COMPENSATION MERIT RATING.*

BY

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Merit rating, as applied to workmen's compensation insurance, is designed both to secure a closer approximation of rates to the hazard of the individual establishment than is afforded by the class rate, and to stimulate accident prevention. These objects are trite enough; what has been less generally recognized is that the two are not wholly compatible. Both, indeed, have to do with hazard measurement; the difference lies in the premium value attached to specific hazards or hazard indicia. From the standpoint of accurate rate adjustment, hazard should evidently be measured in terms of accident cost and the resultant charge imposed without regard to preventability. For the purpose of accident prevention, on the contrary, the penalties should be confined to accident causes within the employer's control and should be sufficient in amount to induce the elimination of the hazards in question. The contrast is most clearly seen in the treatment of what may be termed fixed plant conditions—fixed in the sense that no graduation of accident insurance rates will bring about their alteration. The use of steam boilers and engines, or of line shafting and belt drives, the occupancy of loft manufacturing buildings, or the presence of faults, pot holes and draw slate in the roof of a coal mine, are hazards not common to all establishments within the same industry class,

* The writer was favored with copy of Mr. Mowbray's manuscript on "Scheduled Experience Rating" (*Proceedings*, Vol. III, p. 14) while this paper was still in course of preparation. Mr. Mowbray's proposals partly anticipate, partly traverse, those herein suggested. Both indeed, aim at the same result: a schedule rating system founded upon accident statistics. Nevertheless, it has seemed worth while to publish the present paper, in the hope of eliciting further discussion.

The extent of the writer's indebtedness to the coal-mine rating schedule of the Associated Companies will be evident to all who are familiar with that schedule. Valuable suggestions were also received from Mr. G. C. Kelly of Philadelphia, Pa., who has prepared a very thoughtful paper on somewhat similar lines.

and hence properly chargeable for the purpose of rate adjustment, though it is obvious that no accident insurance charges will induce the abandonment or reconstruction of the plants wherein such conditions occur. Merit rating for the sake of accurate rate adjustment would make much of these and the like conditions; merit rating for accident prevention would ignore them altogether.

Since both prevention and rate adjustment are professed objectives of all merit rating, and since these objectives diverge in the manner above spoken of, every merit rating plan requires to be evalued from both standpoints. It might be urged, indeed, that prevention is no concern of private insurers as such. The business of such carriers is to assume risks; if a given risk is correctly measured and charged for, it is immaterial whether its magnitude be more or less. Bad risks may evidently be as profitable as good risks, so long as the premium is equally adequate. So narrow a view of the insurance function, however, would be extremely short-sighted. To begin with, it is more difficult to gauge abnormal hazards than to determine the mean hazard of the class: the basis rate rests upon a relatively broad exposure, whereas the superimposed charges are necessarily derived from a much narrower experience. Under competitive conditions, accordingly, rates for sub-standard risks are very apt to be inadequate. Apart from this consideration, insurers have a direct pecuniary interest in reducing loss cost because rate changes commonly lag behind experience changes, so that a progressively improving experience redounds to the advantage of insurance carriers. Most important of all, accident prevention is one of the services which employers have learned to expect from insurers and so has become a factor in competitive selection, particularly as between participating and non-participating carriers. Preventive efficacy, therefore, is a valid criterion of merit rating, even from the standpoint of private competitive insurance.

Approached from the public standpoint, the overwhelming importance of prevention would appear to demand that it be made the primary end of individual risk rating. A state or mutual monopoly could very properly adopt this principle, fixing rigorous standards and imposing charges with an eye single to the elimination of avoidable hazards. Under competitive conditions, however, such a course is scarcely feasible, just because the cost of preventive measures bears no determinable relation to the cost of the accidents

thereby prevented. If the rating system were one of credits only, premium income might well be reduced more than pure premiums, whereas a system of charges only might produce an unpredictable excess of premiums over loss cost. The latter result, indeed, might be thought impossible since, *ex hypothesi,* the charges would suffice to correct the conditions charged for, whereupon the penalties themselves would disappear. Insofar, however, as the expense of making the prescribed improvements should exceed the consequent saving in accident cost, the insurers would be assuming the police functions of the state—a rôle not likely to be welcomed by competitive carriers. Besides, the cost of given improvements is by no means a fixed quantity. It is not simply a compound of so much labor and materials, but is affected as well by general plant conditions, methods of work, labor policies, nature of output and urgency of orders. In practice, therefore, even quite severe penalties for remediable conditions would often result in premium increases which could not well be allowed for in basis rates because of their wholly irregular occurrence. Competitive insurers, accordingly, will prefer to make the adjustment of premiums to hazards the principal, and accident prevention the secondary, aim of merit rating.

The discussion thus far has suggested two fundamental criteria of merit rating; a third is given by the requirements of classification rate making. Compensation insurance rates can never safely be built up by mere synthesis of plant, or even of industry, hazards separately determined; the circumstances which affect both the frequency and severity rates of work accidents are so numerous, so dissimilar, so incontinently changing, and, individually considered, so little susceptible of exact measurement, that accident cost (pure premium) experience of the risk class must always be the main element in any tenable system of accident insurance rates. Precisely on this account, merit rating should not be permitted to obscure basis rates. It is, of course, not essential that charges and credits shall exactly balance—neither excess nor deficit is a serious matter if only the amount thereof can be determined in advance; but it is highly important that the premium results of merit rating shall be predictable, both as a whole and by individual classifications.

It follows from these general considerations that any tenable scheme of individual risk rating must: (1) fairly reflect differ-

ences of hazard as between individual establishments in the same manual classification; (2) stimulate accident prevention; and (3) be so constructed that it will at all times be under statistical control. These criteria now fail to be applied to the two accepted forms of merit grading, commonly known, respectively, as "schedule" and "experience" rating. No extended criticism of existing systems is intended, still less is there any expectation of proposing a detailed solution of admitted difficulties. It is hoped, however, that a restatement of these difficulties in the light of generally accepted principles may suggest at least the direction in which a solution is to be looked for.

I.

Schedule Rating.

All of the well-known rating schedules* at present in use are of the same general type; indeed, all derive, in great part, from the same original. From the standpoint of accident prevention these schedules possess three highly meritorious features: they point out specific defects of plant, equipment and shop management which present remediable hazards, they furnish carefully formulated standards of safeguarding and of safety practice for the employer's guidance in removing these defects, and they set a definite money value, in the way of insurance premium, upon each improvement which the employer is asked to make. Prevention is quite as much a matter of education as of incentive and the educational value of the schedule rating standards is unquestionably large. Perhaps not so much can be said of the item values; the charges and credits in many cases are too small to induce compliance with the requirements. So much is this the case that comparatively few employers trouble themselves to ask for reinspection during the policy period. Nevertheless, comparison of first with subsequent inspections of the same risks indicates a substantial degree of improvement in the respects called for by the schedules. How far these betterments will affect accident cost remains to be seen, though there is no room to doubt that their ultimate influence will be very considerable. To have achieved so much at the very threshold of schedule rating is highly creditable to the framers of these schedules.

* The schedules below discussed relate exclusively to manufacturing industries; they comprise the Massachusetts schedule, the Pennsylvania schedule and the Industrial Compensation Rating Schedule (formerly the Universal Analytic Schedule).

As measures of hazard variation, however, the existing schedules are much less happy than as guides to preventive expedients. An inherently impossible attempt has been made to fit all industries into the same procrustean mold; with few exceptions, the same hazards are enumerated and the same values fixed for bakeries and boiler shops, foundries and saw mills, clothing factories and blast furnaces. It was, of course, not overlooked that accident causes vary extremely, in relative importance, from industry to industry, yet such variations are very inadequately allowed for in any of the existing schedules. Most of the item values are measured by equipment units: so much for each defective flight of stairs, each running foot of unfenced shafting, each exposed train of gears and each unguarded machine. Obviously, however, a flight of stairs has not the same importance in a flour mill with one or two employees on each floor as in an overall factory where it is in daily use by two hundred women and girls. The average exposure to a drive belt or a train of gears is not the same in a brick yard as in a boot and shoe factory. Still less can the same insurance value be predicated (as in the Pennsylvania schedule) of a jordan engine and a rod rolling machine. The Industrial Compensation Rating Schedule attempts, indeed, to meet this difficulty by fixing specific values for the point of operation of enumerated machines* and by grading the credit for general guarding of all machines in accordance with the base rate of the industry affected. But these solutions beget about as many incongruities as they avoid. By the first-mentioned device, a dangerous machine, when guarded, receives more credit than a fully automatic machine which needs no guarding; by the second, the value of the same machine is made to vary from one industry to another while machines of very different hazard are valued at the same rate when found in the same industry. It will scarcely be maintained that a buzz planer is twice as hazardous in a carpentry shop as in a furniture factory, or that a bull dozer becomes of equal importance with a vertical drill by being placed in a machine shop. Neither will it be contended that the addition of a number of drop hammers and power shears, fully guarded at the point of operation, reduces the total hazard of an automobile factory. If the per unit values thus fail to allow sufficiently for differences between industries, still less are such variations reflected by the percentage items. Power transmission,

* A device borrowed from the Massachusetts schedule.

e. g., is greatly more important as an accident cause in planing mills than in iron foundries, yet the latest evolved rating schedule gives equal weight to individual motor drives in the one case as in the other. The same criticism obviously holds of the percentage limitations upon working machine credits—it is too high for blast furnaces and altogether too low for wood working establishments. Even safety organization and first aid provisions can scarcely be said to possess the same value, relatively to total hazard, in clothing factories and steel mills.

None of the existing schedules, in short, reflects plant hazard with even approximate accuracy. Per unit charges and credits tend to be excessive for industries wherein the mechanical equipment bulks large in proportion to payroll exposed,* as also for low-rated industries and low-rate states.† Payroll charges and credits similarly tend to excess when applied to low base rates, not to mention that some of these items amount to flat discounts for the normal conditions of certain industries.‡ When it is added that the item values, whether per equipment unit or proportionate to payroll or to premium, in no case reflect statistically determined hazard quantities, the erratic results of schedule rating are a foregone conclusion. Transmission charges, alone, in particular establishments, have been known to exceed the manual premium calculated to cover the total average hazard of the industry. Conversely, the working machine credits alone of the Industrial Compensation Rating Schedule may approximate the total premium§—a contingency

* This would be true, e. g., of flour milling, stone crushing, and textile manufacturing.

Incidentally, it may be remarked that the per unit charges discriminate unfairly against the small risks, for the payroll exposure per unit of equipment is apt to be less in small than in large establishments.

† The specific charges of the Industrial Compensation Rating Schedule, e. g., would be nearly twice as great, in proportion to manual premium, in Pennsylvania, as in New York. Yet the projectors of that schedule appear to have thought that a limited test upon New York risks alone would sufficiently indicate the premium results in all states.

‡ One story buildings, e. g., are the rule for foundries, steel mills, and stone yards.

§ The annual premium on a silk mill, at Pennsylvania rates, would probably not exceed 65 cents per employee. The credit for general guarding of machines—to say nothing of point of operation—might easily come to 35 cents. The maximum credit of 10 per cent. of premium could be obtained by guarding one-fourth of the machines.

met by the stop limit which gives the same credit for a partly guarded plant as for one that complies with the schedule standards in all respects. Hence practical application of the schedules produces rewards and penalties for industrial establishments that are disproportionate to actual hazard variations, and, at the same time, yields irregular increases and decreases of premium income from the several manual classifications, which increases and decreases are unrelated to any ascertained variation of loss experience.

These shortcomings would be the less serious if schedule rating were subjected to definite statistical control. No one expects finished results from first experiments. But it surely is not too much to expect that each experiment shall be fully utilized for further progress, and this implies that its results shall be quantitatively determined, both in gross and in detail. We need to know, on the one hand, for schedule rated industries as a whole and for each important industry group, both the gross premium effect of schedule rating and the weight of each scheduled item in producing this effect; on the other hand, we need to check the loss experience on schedule rated risks against the charges and credits developed by the schedule. Unhappily, such an analysis of existing schedules is not merely wanting, but is even well-nigh impossible. So far as the writer is aware, no attempt has anywhere been made to check loss experience against schedule rating results, nor have any plans been formulated looking to that end—which is to say that insurance carriers have not sought to ascertain whether they are receiving, or are likely to receive, a *quid pro quo* for their immense outlays upon inspection and rating service.* Of the Universal Analytic Schedule we know only the gross premium results, subdivided by large industry groups and by size of risk. Of the Pennsylvania schedule, alone, do we know the premium charges and credits by industries and by items. Even these returns, in both cases, are based upon estimated, not audited, payrolls. Yet this meager, and sometimes misleading, information is all we are likely ever to obtain of any extant schedule. The causes of this untoward situation lie quite as much in the defective structure of the schedules themselves as in any want of statistical enterprise.

* Inspection service is, of course, partly competitive in purpose and its cost may properly be charged, in part, to expenses of acquisition. So far as inspection is effective for this end the carriers do receive a *quid pro quo*, irrespective of loss results. The statement in the text refers only to the ostensible purposes of accident prevention and equitable rating.

To take only the best known example, the structure of the Industrial Compensation Rating Schedule is such as nearly to defy statistical analysis. The several item values are computed upon no less than three distinct bases: cents per $100 of payroll, per cent. of base rate, and flat amounts per unit of plant equipment. To be sure, these various magnitudes, though dissimilar, are not actually incommensurate; all may be reduced to a common denominator of either rate or premium. Such conversion, however, is more than a statistical complication in the way of determining the effective weight of specific items; it rests, besides, upon an estimated payroll which is always more or less wide of the mark. Indeed, the actual method of converting flat charges and credits into premium rates offers a direct inducement to misrepresentation of payroll, because a very substantial saving may often be effected by a shrewdly calculated under- or over-estimate*—a fact of which insurance brokers are not slow to take advantage. The stop limits present a difficulty of another order, making it impossible, for example, to prognosticate the effect of a given change in working machine credits.† The obstacles to a realistic test of the item values are still more formidable than any yet mentioned, for the items themselves, in their present form, do not fit into any recognized or practicable classification of accident causes. It would, of course, be feasible to ascertain the total premium results of the schedule upon audited policies and to check these results against loss experience upon the same risks. Such an analysis, however, could only show whether the schedule has adversely affected premium income as over against loss cost; it would not avail for the correction of untoward developments, because it would not

* An overestimate will be advantageous to the assured wherever there are many flat charges and few flat credits. Thus upon a true payroll of $100,000 with a $1 rate, flat charges of $150 and percentage or payroll credits of 12 cents would give a net rate *increase* of 3 per cent. If the payroll in this case were estimated at $150,000, the result would be a net *credit* of 3 per cent. At the same time an overestimate of the number of employees will increase the credit, or reduce the charge, for the number of working machines. On the contrary an underestimate of payroll is indicated where there are few flat charges and many machine credits.

† This obstacle might be overcome by a count of guarded machines in excess of the credit limit. But since the point of operation credits are not uniform even within a given industry, it would be necessary to keep a statistical account of each listed type of machines, which would mean a staggering number of cards for a single sizable risk.

reveal either the premium effects or the corresponding hazard values of the several items which go to make up the schedule.

The foregoing criticisms are offered in no carping spirit, nor with any intent to disparage the very substantial merits of the schedules so criticized. On the contrary, it is believed that the deficiencies pointed out can be corrected without abandoning the ground already gained. These deficiencies, it will have been observed, relate, not so much to the items covered, as to the item values and to the organic structure of the schedules. If the above analysis is at all correct, it will be needful: (1) to construct several schedules, each appropriate to a single group of related industries; (2) to derive the item values for each industry group from statistical experience; (3) to relate these values to the total hazard of the industry affected in such a way that schedule rate variations shall correspond, quantitatively as well as qualitatively, to hazard differences, and (4) to devise a structural plan such that the results of schedule rating shall be readily amenable to statistical analysis and control. The details of such a program are obviously far beyond the competence of a mere statistician, yet it may be possible to suggest a method of procedure for carrying it into effect.

The first of the suggested steps should not prove extremely difficult. Underwriters have long recognized that certain industries are closely related to each other in kind and degree of hazard—a relationship dependent upon analogy of industrial processes. What is needed is a systematization of the present somewhat rough-and-ready groupings by an engineering and statistical investigation of component hazards. It is believed that such an inquiry would eventuate in a moderate number of groups, each sufficiently homogeneous to be covered by a single rating schedule.

The determination of item values is a much larger undertaking. Mr. Mowbray has proposed the method of sectional pure premiums. Whether he has in mind an average pure premium, derived by simple addition of the losses and exposures of all states, or a basic pure premium computed by the method of law differentials, is not altogether clear. Values obtained by the former method would evidently be excessive for low rate, and deficient for high rate, states, whereas the law differential method, when applied to each of a considerable number of accident causes and modified by what may be termed partial differentials for different classes of injuries —a step even more necessary for sectional than for total pure

premiums*—would prove extremely laborious. It would, moreover, yield as many sets of item values as there are law differentials—a circumstance which would greatly complicate the application of schedule rating. Still less does it appear feasible to determine the accident cost per unit of equipment. Such an undertaking might present no insuperable obstacles as respects elevators and traveling cranes, but, when carried out for the immense number and variety of features which a rating schedule must take into account, it would involve, beside all the difficulties of sectional pure premium computation, an additional source of error in the shape of inadequate exposures. Mr. Mowbray, indeed, proposes nothing of the sort. If I have rightly understood his plan he would fix a rate on the entire plant payroll for each sectional hazard, as buildings, elevators, transmission, working machinery, etc., and would arrive at the establishment rate by summation of these sectional rates. Assuming that such a plan is workable—upon which question the present writer is not prepared to express an opinion—it would be necessary to grade the sectional hazards in respect of quantity as well as quality. If it be granted for the moment that the elevator pure premium is the same for shoe factories as for department stores, how take account of variations in the number of elevators per $100,000 of establishment payroll? Doubtless, such variations could be expressed in the sectional rate-grade, though only, it would seem, at the cost of much complexity.

On the whole, it would appear simpler, and at the same time sufficiently accurate for the purpose in hand, to build up a rating schedule on the basis of item values expressed as fractions of the group pure premium. This would involve merely the determination of the number and severity of accidents ascribable to each cause, and the assignment of a severity weight to each accident in accordance with some standard scale. The statistical committee of the International Association of Industrial Accident Boards and Commissions has already proposed such a plan whereby the severity of temporary disabilities is to be expressed in terms of actual time loss, that of deaths and permanent total disabilities in

* The total law differential between New York and Wisconsin, e. g., may be taken at 150, but the differential for medical aid is barely 100, for temporary disability benefits about 70, and for death benefits more than 200. Hence the true law differential for electrical injuries, in the cost whereof death benefits greatly preponderate, would be very much different from that for hand tool accidents, the cost of which mainly consists in medical and temporary disability benefits.

terms of working life expectancy, and that of permanent partial disabilities in fractions of permanent total disability, as given, say, by the Imbert Scale. Details of this plan have still to be perfected, but the task should easily be within the resources of members of this Society. Absolute accuracy could not, of course, be claimed for such a method of valuation. Yet if the same method were applied to the industry group and to each component hazard, the relative values should be approximately accurate, and it is only relative values which need to be established for the present purpose.

Purely by way of illustration, the writer has computed, upon the basis of Ohio and Wisconsin experience, the cause-group values for the manufacturing and, separately, for the wood-working industries of those states. It is, of course, recognized that the experience here used is insufficient and, further, that the statistics themselves have not been fully analyzed from the present point of view, so that the values had to be derived, in part, by the method of imputation. Nevertheless, the results for each state agree rather closely with the combined results, so that the whole may be taken as sufficiently accurate for illustrative purposes. The cause groups are those formulated by the statistical committee of the International Association of Industrial Accident Boards and Commissions, with certain minor rearrangements. For schedule making these groups could, of course, be subdivided or recombined to such extent as might be deemed expedient. It will at once appear from the subjoined table that barely one-half of the total hazard in these industries is attributable to mechanical causes, even when that category is extended to comprise boilers and other steam-pressure apparatus, electrical installation, and railway equipment. On the other hand, a fair proportion of non-mechanical accidents arise out of remediable conditions of plant and equipment. Thus analysis of the Wisconsin data included in the table indicates that 5 per cent. of the weighted time loss from falls of persons in the manufacturing industries of that state are due to falls upon stairways, 25 per cent. to falls from balconies, runways, platforms and trestles, 18 per cent. to falls into vats, bins and tanks, and 10 per cent. to stumbling over obstacles in passageways and falls upon uneven, defective or slippery floors. When all such allowances are made, however, there will still remain a large number of accidents which cannot be definitely related to specific items in a rating schedule, though they may be taken account of in arriving at the value of safety organization and education.

RELATIVE IMPORTANCE OF ACCIDENT CAUSES IN INDUSTRIES SUBJECT TO SCHEDULE RATING AS MEASURED BY THE NUMBER AND SEVERITY OF ACCIDENTS ASCRIBED TO EACH CAUSE.*

No.	Causes.	All Manufacturing.†	Wood Working.‡	No.
1	All causes	100.0	100.0	1
2	All machinery	47.1	51.	2
3	Prime movers	1.5	1.0	3
4	Transmission apparatus	7.8	9.0	4
5	Working machinery	24.5	37.5	5
6	Elevators	6.6	2.5	6
7	Cranes and conveyors	6.8	1.0	7
8	Boilers and steam pressure apparatus‖	.8	.5	8
9	Vehicles, power and animal¶	3.3	1.5	13
10	Electricity	1.6	1.0	9
11	Explosives	.6	0.0	10
12	Conflagrations	.3	0.	11
13	Hot, corrosive and poisonous materials	6.4	.5	12
14	Falls of persons	12.1	12.5	14
15	Stepping on or bumping against objects	2.5	3.5	15
16	Falling objects	6.6	8.	16
17	Hand tools	5.4	4.5	17
18	Objects being handled**	12.7	15.0	18
19	Other causes	.8	2.0	19

* Based upon work accidents in Wisconsin, July 1, 1912, to Dec. 31, 1914, and in Ohio, Jan. 1, 1914, to June 30, 1915. The statistics were taken from the official reports of the industrial commissions of those states, supplemented by some special analyses for which the writer is indebted to Messrs. F. C. Croxton and W. H. Burhop.

The weighting system employed is explained in the *Bulletin* of the Industrial Commission of Wisconsin issued August 1, 1915, and entitled "Industrial Accidents."

The percentages given represent total accident weight (number of accidents by severity weight of each).

† Based upon 44,386 compensatable accidents—i. e., accidents which caused death, permanent disability, or temporary disability for more than one week.

‡ Based upon 5,092 compensatable accidents as above defined.

‖ Includes explosions of and escape of steam and hot water from, but excludes other boiler-room accidents.

¶ Includes falls of persons from, while in motion. Probably includes also some accidents improperly charged to manufacturing classifications.

§ Excludes objects dropped in carrying, lifting, loading or unloading.

** Includes hand truck accidents, and all accidents in carrying, lifting, rolling, loading, unloading, or other handling of objects, all without the use of mechanical or animal power.

Structurally, the scheme herein suggested would follow the coal-mine rating schedule of the Associated Companies. Substandard features of the given establishment would be graded in deficiency points whose relative weights would be fixed by the cause-group values already explained. The schedule rate of the establishment would then be determined by the formula:

$$R = B(1 - U) + UB\frac{X}{L},$$

where R is the establishment rate, B the basis rate, U the maximum allowable discount (in per cent. of base rate), X the number of deficiency points developed by the establishment in question, and L the normal number of such points for the industry group. The items in respect to which risks would be graded might be much the same as in the existing schedules, save that their values would be expressed in points convertible into percentages of base rate. The device of the normal allowable points of deficiency, or the number of deficiency points equivalent to base rate, is introduced to secure a balance of premium increases and decreases upon schedule rated risks. Normals for each industry group would, of course, be determined statistically, by analysis of actual inspection reports. Such determination, however, would be comparatively a simple matter; it is even probable that existing inspections would afford sufficient data for the purpose.

The practical operation of such a schedule may conveniently be illustrated from the treatment of the machine hazard in wood-working establishments. The tentative table of values already recited indicates that working machines comprise 37.5 per cent. of total hazard in this group of industries, or 37.5 charge points in a total of 100. The working machine charges of a particular risk would then bear such ratio to 37.5 points as the number of unguarded machines per 100 employees bears to the normal proportion of working machines in the classification to which the risk belongs. Algebraically the computation may be expressed:

$$N = 37.5\frac{\frac{WM}{100}}{\frac{LWM}{100}} = 37.5\frac{WM}{LWM},$$

where N is the number of machine charges (in points), $WM/100$

the actual number of working machines per 100 employees, and *LWM*/100 the normal proportion for the classification. In computing the ratio, *WM*/100, a completely guarded machine should count for only a fraction (say one-half) of the full machine hazard. Similarly, separate allowance might be made for guarding at the point of operation, as distinguished from general guarding. It might even be feasible to assign different weights to different types of machines, so that a square-head jointer, e. g., would count for more than a turning lathe. These, however, are matters of engineering detail. The distinguishing feature of the proposed method of treatment is that all phases of working machine hazard—type of machines, quality of guarding and amount of equipment per unit of exposed payroll—sum up in a single ratio to total hazard of the industry. Sash, door and blind establishments, e. g., grade all the way, in character of operations and of output, from planing mills to furniture factories. Under the proposed plan, mill "A," with the full classification number of working machines (92 per 100 employees) would receive the full charge of 37.5 points if all machines were unguarded ($N = {}^{92}\!/_{92}$ 37.5), and one-half charge, or 18.75 points, if all machines were completely guarded ($N = {}^{46}\!/_{92}$ 37.5). Under the like conditions mill "B," which has only 69 machines per 100 employees, would carry, respectively, 28⅛ and 14$^{1}\!/_{16}$ points [$N = {}^{69}\!/_{92}$ 37.5 and $N = {}^{69}\!/_{92}$ 37.5]. That is to say, the machine charge ratio between the two plants is the same when both are completely guarded as when both are wholly unguarded: the premium rate expresses the quantitative relationship in mechanical hazard. The like result, obviously, cannot be predicated of any existing schedule.

It is believed that the method above sketched for the rating of working machines could be applied as well to transmission apparatus; perhaps also to traveling cranes, elevators, and certain other hazard features. Other hazards, apparently, could only be measured by the unit method; such, for instance, are defective floors, unrailed stairways and unprotected balconies. Some features, lastly, and those not the least consequential, would probably be subsumed under the somewhat vague captions of safety organization and safety measures, whereof no statistical valuation appears to be possible. In short, neither the plan herein outlined, nor any other yet proposed, would altogether do away with judgment values. The hazard of a guarded as compared with an unguarded

punch press, of individual motor drive as compared with shaft transmission, or of a variety shaper as compared with a belt sander or a buzz saw, the accident prevention value of toe boards per 100 feet of overhead balcony, or the accident insurance cost of a hole in the floor, can never be mathematically determined. The suggested plan, however, would limit the function of personal judgment, except in the realm of so-called "moral" hazards, to fixing the relative weights of individual items within a group whose total weight is statistically determined.

It has already been intimated that the method of rating by specific hazard values will not hold for such features as safety organization and education, first aid provisions, character and permanence of the working personnel, methods of work, shop discipline, and whatever else may be comprised within the undefined limits of "moral hazard." It cannot be safely assumed, as was done in formulating the coal-mine schedule, that these features of plant management affect only that residue of accident causes for which definable conditions of plant and equipment fail to account. On the contrary, these intangible elements affect for good or ill every source of accidental injury. For that very reason, their value, though unquestionably large, is indeterminate: they cannot be isolated in a given establishment, nor can their results be satisfactorily compared from establishment to establishment on the "other-things-equal" assumption—other things are never equal in the requisite degree. Moral, or, to borrow Mr. Mowbray's expressive term, morale, hazards, do not lend themselves to objective determination by a rating inspector; they must be graded, if at all, by more or less arbitrary indicia whose validity rests upon personal judgment. When it is added that the total weight of the moral hazard group, no less than the relative weight of each specific indicium, is almost wholly a matter of personal judgment, it will appear that these hazards can scarcely be fitted into a rating schedule based upon analysis of accident causes. On the whole, it would appear preferable to measure establishment morale by means of experience rating, and to take account in schedule rating only of conditions which can be ascertained by inspection and the approximate values of which can be derived from accident statistics.

To recapitulate: It is proposed to construct several industry-group schedules, each limited to such tangible hazards as can fairly be graded by inspection, to derive the premium values of these hazards

from accident statistics, and to apply the values thus determined to the grading of individual risks by means of score points which shall bear a simple ratio to classification basis rates. These proposals, though they may be new in their present application, are by no means novel in themselves. In essentials, the scheme above outlined is taken bodily from the coal mine rating schedule of the Associated Companies. What is here attempted is to show that a schedule of the same type can be adapted to manufacturing industries and that this type of schedule, more nearly than any of the existing systems, would fulfill the fundamental requirements of schedule rating: namely, effectiveness for accident prevention, equitable rate adjustment and facility of statistical control.

1. As a stimulus to accident prevention the suggested scheme should prove not less effective than the best existing schedules. Not only would it possess the same features of definite standards, specific enumeration of defects, and direct pecuniary incentive; it would set a more adequate value upon the major hazards, and it would allow full credit only for full compliance with the prescribed requirements.

2. Since the item values of the suggested schedule would be proportionate to hazard weights in the particular industry group, and since the establishment rate produced by the application of these item values would express the actual degree of compliance or noncompliance with prescribed safety standards, the resultant premium increases and decreases should bear a tolerably close and uniform relation to establishment hazard. That the proposed plan would afford an exact measure of hazard differences between establishments, even as respects the hazards taken into account, cannot, of course, be pretended. It should, however, give a far closer approximation to such a result than can ever be attained by a rating system built upon judgment values.

3. Lastly, the structure suggested is such as to facilitate intelligent control. Inasmuch as all item values would be equivalent to percentages of basis rates, the premium effect of each item could readily be determined. The values themselves could be revised whenever necessary from later statistical experience and the premium results of such revision could be predicted with reasonable accuracy. The same remark would hold equally of the normal deficiency points for each industry group. These normals, indeed, would afford the readiest means of maintaining a balance of premium increases and decreases, for any excess or deficit could ob-

viously be wiped out by changing the value of either U or L in the formula $R = B(1 - U) + UB(X/L)$. This high degree of flexibility is not least among the merits of the proposed hazard grading schedule. No system of prospective rating, not even the basis rates themselves, will ever achieve a perfect balance of projected with realized losses. To say nothing of inadequate exposures and of errors of judgment or of computation, accident rates are ever fluctuating from causes which cannot be foreseen. Whence the necessity that every element of rate making, whether for risk classes or for individual risks, shall be kept under continued statistical observation and control.

This paper has already so far overpassed reasonable grounds that any consideration of experience rating must be deferred to a later occasion.