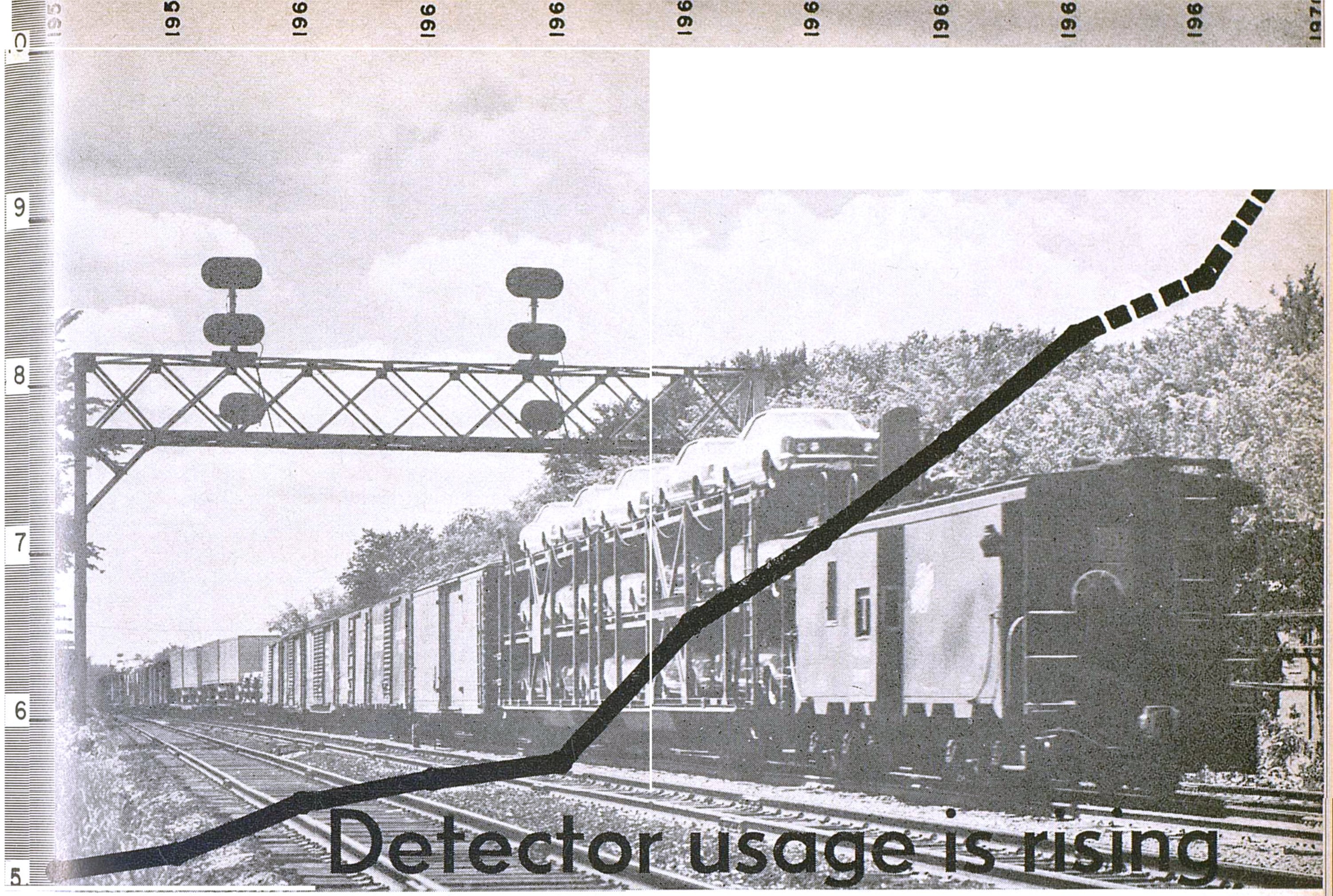


Detector usage is rising

Trains, such as the one above, are under the watchful eyes of automatic devices which detect dangerous or potentially hazardous conditions that might cause derailments. These conditions include overheating of journals, loose wheels, broken flanges on wheels, dragging equipment, high or wide loads, bridges out of alignment, falling rock, high water, mud or earth slides, etc.

Reasons for employing such detectors are many: (1) There are fewer people than formerly along the right-of-way to watch passing trains for possible defects. Also, there are fewer people patrolling the track to look for hazardous conditions that might interfere with safe train operation.

(2) The cost of replacing today's freight train and its lading is of significant value. For example, a 100-car, auto-rack train, fully loaded, is estimated to be worth about $6 million. Admittedly, it is rare indeed, for an entire train and its lading to be damaged or destroyed in a derailment. However, the higher value of today's trains makes derailments expensive.

(3) Operating freight trains at higher speeds (some at passenger train speeds of 60 mph or more) make it more difficult for the human observer to detect defects on these trains.

(4) With respect to overheated journals, improvements in lubrication with the use of roller bearings or lubricator pads around plain bearings, make it more difficult to detect abnormal conditions. The tell-tale smoke and flame of waste packing are no longer the obvious signs of overheated journals. Hence, the human observer is now often unable to detect overheated journals which threatens the safety of a train.

(5) Rising costs of labor, equipment and materials as well as general inflation makes derailments more expensive as time passes.

Interstate Commerce Commission data concerning derailments as reported by U.S. railroads indicates that the average derailment causes only $25,000 damage to track and equipment (freight cars and locomotives). This figure is considered by many knowledgeable persons to be an understatement of the real financial outlay for a derailment. For example, other costs include:

- Labor and materials required by the wreck crew in cleaning up after a derailment.
- Costs to cover repair or replacement of damaged signal and communications facilities.
- Labor and materials for restoring the line to normal service.
- Costs of detouring trains, if necessary, until normal operation is restored.
- Loss and damage to freight, and costs not covered by insurance.
- Intangible costs including loss of future business by shippers who feel a railroad has "too many" derailments. Delays to shipments directly or indirectly involved in the derailment also incur shipper dissatisfaction.

Thus, a careful examination of the costs incurred by a derailment might well run up to $250,000 or more. This quarter of a million dollar figure is estimated by many experts to be a more realistic figure to use for the cost of a derailment, than the $25,000 average that has been reported by the ICC.

The previous discussion has been concerned with derailments along line-of-road to moving trains. There are dangerous conditions that might or do cause derailments in yard areas. While these are not usually serious, considerable damage can occur. In general, detectors can be operated in line-of-road service. However, the broken flange detector is normally used in approach to yards or in other territories where speeds do not exceed 30 mph.

DETECTOR USAGE DOUBLES IN 10 YEARS

As the graph on the previous page indicates, detector usage is increasing. The number of detectors in service has almost doubled since 1957. Part of the increase is accounted for by the introduction of new types of detectors not previously available, or perfected to the extent that widespread application was practicable. Such devices would include presence, snow and clearance detectors (high, wide load detection devices). Also, the hotbox detector made its debut in 1957. Indications are that railroads will install well over 250 detectors of all kinds annually for the next several years.

Although not measureable in equipment units, the well-known rock slide fence is still being installed to protect rights-of-way from falling rocks that might block the track. Railroads are installing well over 15,000 ft yearly of this type of detection device. Usage is based upon the unavailability of manpower to patrol the right-of-way, as well as the need for continuous protection.

Some railroads use ordinary stock fencing with wires loosely stapled at intermediate posts, but attached at each end of a section to a cross member which in turn is attached to a circuit controller, tension in the fence being maintained by springs. Operation of the circuit controller may set a signal to Stop or it may cause an indication lamp to be lighted to alert crews of moving trains of the hazardous conditions. Such fences are usually located near the tracks or up the slope as required. Where rocks fall from cliffs, overhead network fences can be used.

At some locations, soft mud or earth slides down from banks onto the track. At such places some railroads use low fences constructed of planks on posts which are jointed at the ground line with sections that break easily. Mercury-level circuit breakers detect any movement of the fence from vertical. A fence to detect snow slides has been used by railroads in mountainous snow country. When snow pushes against the fence, a plug is pulled to open a circuit. This action causes detection signal indicators to be lighted to alert train crews.

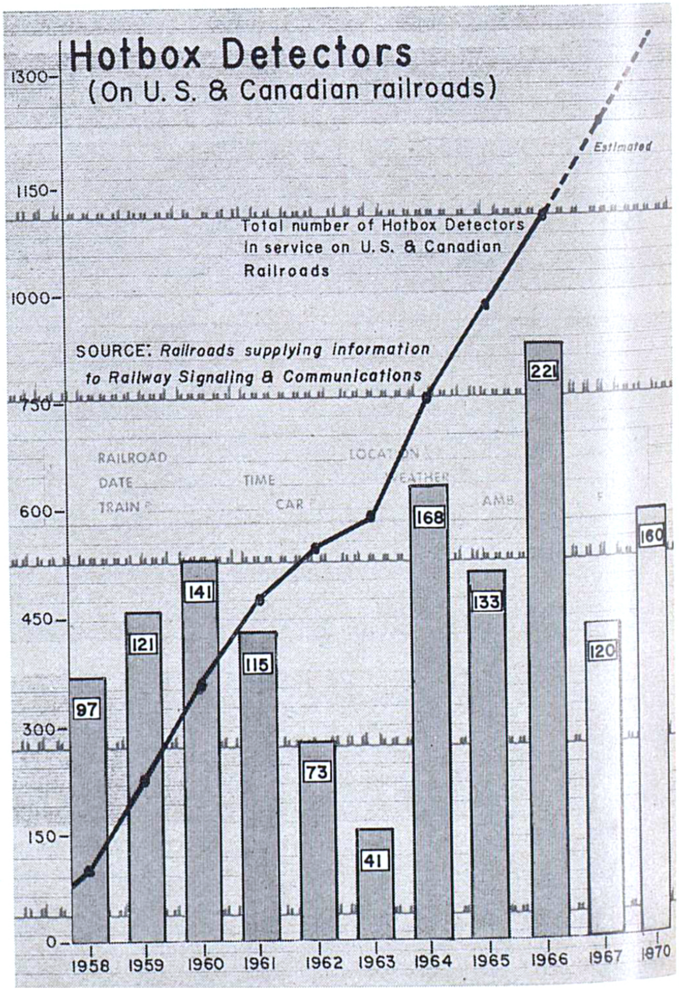
Some of the more potent reasons for installing detection devices are listed in the table on the opposite page. Shown is a listing of some of the more common causes of derailments which are subject to detection by automatic devices. Even taking a conservative estimate of $200,000 for the cost of a derailment, the six causes listed cost the railroads about $129 million in 1965. Of this total, by far the largest ($90,800,000) is attributed to derailments due to overheated journals.

The reasons for the rise in derailments due to overheated journals are difficult to pin point. Informed persons, however, point to the increase in the total car fleet, the higher freight train speeds, and finally to the competitive pressures to provide service with least delays. This latter factor, according to some experts, may result in hasty car inspections in yards due to management pressure to get trains out on time.

During this 1965 period when derailments due to hotboxes totaled 454, the cars set off between terminals with hotboxes totaled 24,267. According to our companion publication *Railway Locomotives & Cars,* only 469 of these set offs involved roller bearings. For 1966 (according to *RL&C*), there were 19,924 set offs due to plain-bearing failures and only 440 set-offs due to roller and other bearing failures. Hopefully, these figures may indicate a decline in the number of derailments due to overheated journals. However, data on this situation is not yet available for the year 1966.

Railroads have and will probably continue to install hotbox detectors at a rate of better than 125 per year. Practice on many railroads is to install hotbox detectors in approach to major yards, and at entrances to smaller yards where car inspection forces are located. Detectors are usually located 5 to 10 miles out to catch inbound trains. Some railroads with such installations, will only inspect those journals that are overheated or indicated to be in an abnormal condition (warming up, but not hot). For line-of-road and yard exit detection, hotbox

Hotbox detector usage grows



Derailments reported to ICC indicate need for detectors

Cause	1958	1959	1960	1961	1962	1963	1964	1965
Broken Flanges	61	46	35	36	55	56	53	54
Loose Wheels	43	67	67	62	75	68	57	77
Overheated Journals	560	659	639	471	346	401	449	454
Brake Beam Broken	81	67	50	22	29	27	21	18
Brake Rigging Down	22	14	24	21	26	28	12	20
Steam Heat Connections Dragging	15	18	12	13	11	15	19	24

detectors have been installed at 25-30 mile intervals. However, recent experiences of a number of railroads indicates that closer spacing, possibly on a 20-mile interval, will be required to prevent burn-offs. One road attributes such shorter distances for overheating to utilization of high horsepower locomotives capable of greater acceleration, and the operation of freight trains at higher speeds.

AUTOMATIC INSPECTION STATIONS

Several railroads have installed multiple detectors at a single location. A generally accepted practice on many roads is to install dragging equipment detectors at hotbox detector sites. One railroad has added a loose wheel detector to this combination. Others are considering adding a high, wide load or clearance detector where these other devices are located in approach to tunnels or overhead bridges where clearance might be restrictive. In such cases, the approach distance would be such that the train crew could be alerted with sufficient time and distance to bring the train to a stop prior to reaching the restrictive clearance.

At hotbox detector locations, wheel detectors are placed so as to provide (among other functions) wheel counting information. This makes it possible to obtain information as to which car is in trouble without the need to look at the detector printout on recording chart paper. The addition of an automatic car identification scanner would provide car initial and number, thus pinpointing the specific car in trouble.

Initial installations of these inspection stations will undoubtedly be at the more seriously restricted areas, that is, in approach to tunnels and overhead bridges with low clearances. For the longer view, thinking is that such inspection stations will bracket major yards to provide automatic inspection of arriving and departing trains. In addition to spotting potentially dangerous or overheated journals, the high-wide load detector might spot shifted loads. These are but two examples of what such an inspection station could do to alert yard forces concerning an arriving train. With such an automatic inspection station, yard forces could concentrate on correcting the indicated defects. Outbound trains would pass such an automatic inspection station for a check of their condition at the beginning of the long journey to the next major yard or terminal.

Most dragging equipment detectors in service today are of the self-restoring type. They consist of sheet metal panels bolted to a horizontal shaft mounted on bearings between two track ties, so that the top edge of the panels is about level with the top of the rails. When dragging equipment, such as brake beams, brake rigging or broken steam heat connections, strikes one of the panels, the shaft is rotated a few degrees, operating a circuit controller. Then spring pressure returns to normal position.

Dragging equipment is most likely to cause derailments at switches where turnout rails may deflect the loose parts under the wheels. These detectors are often placed in approach to interlockings which include numerous switches and crossovers. Also, they are placed in approach to bridges and tunnels where a derailment might cause serious damage and may block the tracks. And, it is almost universal practice to install dragging equipment detectors on the track approaching the hump in retarder classification yards.

The broken flange and loose wheel detector consists of a series of spring steel fingers, at right angles to the rail, with an insulated hardened steel pad near the end of each finger. The upturned end of each finger extends a fraction of an inch above the top of the rail. The flange of a normal wheel encounters the insulated pads and depresses the upturned fingers away from the tread of the wheel. If a section of the flange is broken out, the contacting finger tips touch the tread. This completes an electrical circuit and causes a relay to operate. Loose wheels which fail to stay on the insulated pad are also detected.

Another version of this device will only detect loose wheels. This device consists of a section of spring steel mounted inside the rail allowing a normal wheel to pass through. A loose wheel will press against the spring steel bar and actuate a circuit controller.

These detectors can be equipped with an associated marking unit that will automatically spray paint on the wheel that is defective.

Flood detectors include cork floats which rise with the level of water. By using a long rod from the float up to the controller, this controller can be at a level convenient for inspection. A latch holds the float in the raised position until a signal maintainer or track foreman arrives to check flood conditions. Flood detectors are usually located adjacent to bridges and alongside embankments. Some railroads have installed such detectors at points up stream to detect oncoming rushes of water caused by heavy rainfall which might cause flash flooding of the right-of-way.

FIRE DETECTION, TOO!

Fire detectors are usually located along timber trestles, on wood bridge decks, along timber snow sheds and adjacent to other wood structures which, if they catch fire, can create a hazardous condition. Typical construction consists of insulated No. 10 copper wire supported on porcelain insulators with a 2-inch soldered lap joint between each set of insulators. The solder melts at a relatively low temperature. If fire melts the solder, the weight of the wire opens the joint, thus opening a circuit to operate a detector relay.

Several rapid transit authorities have made extensive use of smoke detectors in relay rooms and interlocking towers located underground in subway systems. Here, damage from fire can be extensive. Also, fires may smolder a long time before bursting into flame. Hence, smoke detectors are effective in alerting personnel about the early stages of a fire. In most instances it can be extinguished before great damage is done. In some installations, these smoke detectors are used in conjunction with automatic sprinklers. However, conventional practice is to employ the smoke detector with auxiliary alarm equipment such as a horn or siren at the location and an alarm lamp located in the dispatcher's office.

Bridges have, on occasion, been knocked out of alignment or piers have settled pulling a bridge into a slight mis-alignment. In either case, it may create an unsafe condition for the passage of trains. A few railroads in the lumbering regions of the U.S. and Canada have had bridges over highways knocked out of alignment due to trucks carrying logs pyramided to above the clearance limit. One railroad constructed a bridge alignment detector out of a rail placed at the clearance limit along side the bridge and crossing the highway. A wire strung along the rail was connected to a circuit controller. If a high load on a truck hit the rail, it would break the wire, opening the circuit. In this particular installation, the detector was interconnected with the automatic block signal system, so that actuation of the detector would set a signal to stop.

To check pier alignment and the relative position of the end girders and the abutment piers a different type of detection method is used. The detector consists

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Who makes detectors? - - - a selected list

Broken or loose wheel detectors: Railroad Accessories Corp.; Wheel Checkers

Dragging equipment detectors: General Railway Signal Co.; Hanlon & Wilson Co.; Union Switch & Signal division of WABCO; Wheel Checkers

High and wide load (clearance) detectors: General Electric Co.; Hanlon & Wilson Co.; Railroad Accessories Corp.

Hotbox detectors: General Electric Co.; General Railway Signal Co.; Railtron Corp.; Servo Corp. of America

Presence (or wheel) detectors: General Electric Co.; General Railway Signal Co.; Link division of General Precision Inc.; Radio Corp. of America; Railroad Accessories Corp.; Servo Corp. of America; Western Railroad Supply Co.

Slide fence detection: General Railway Signal Co.; Union Switch & Signal division of WABCO.

Snow detectors: Railroad Accessories Corp.; Rails Co.; Vapor Corp.

DETECTOR USAGE IS RISING

(Continued from page 16)

of a heavy pendulum which normally hangs vertically. If it swings off center, it breaks a short strand of fine wire, thus initiating a warning. To check the normal position of a girder, a terminal on the end of this girder is connected by a fine wire to a second terminal directly opposite on the face of the masonry of the pier. The wire will be broken if the girder moves away from the pier more than one inch in excess of normal contraction. A relative change of horizontal alignment can likewise be checked.

Similar to the pendulum-type bridge detector, is another detector for alerting personnel about earthquakes. One railroad, with a mainline through territory that has had serious earth tremors, has developed a device that will detect 12 different ranges of intensity of earthquake action. When the detector is actuated, information as to the intensity of the tremor is transmitted to the dispatcher.

DETECTORS IN TERMINAL AREAS

While most of the detectors mentioned previously have major application on line-of-road, snow and presence detectors find much usage in terminal areas as well. This is not to say that the other detectors are not found in terminal areas, but most of them are located out along the right-of-way. Broken flange detectors, because they are generally limited to territories where speeds are no higher than 30 mph will be found in terminal areas. In fact, a growing trend is to place broken flange detectors on hump approach tracks at retarder classification yards.

Although encrusted snow and ice in switches, may not cause serious derailments, such obstacles to good operation do cause train delays. Snow detectors are usually used in conjunction with switch heaters. Some roads install snow detectors at outlying interlockings and at CTC power switch locations. When the detector is actuated, an alarm light is illuminated on the dispatcher's CTC panel or on the towerman's interlocking control machine. One road, and others are finding the practice worthwhile, has interconnected the snow detector circuitry into switch heater controls. Thus, actuation of the snow detector turns on the switch heaters. When snow or ice ceases to be a problem, the snow detector will turn off the switch heaters. However, a timing circuit is usually incorporated in the switch heater controls also may have a temperature sensing unit) so that the heaters are not turned off until the ice and snow has melted from the switch area.

Some snow detectors operate on the principle of the falling snow striking a screen and melting. The small pool of water completes an electrical circuit. Other detectors are of the ultrasonic type which have their sonic beams interrupted by the falling snowflakes.

To prevent switches from being thrown under cars in retarder classification yards, track circuits are usually used. Most of the automatic yards use circuits 55 ft long for these switch detector sections. However, the addition to the railroad car fleet of TOFC and COFC (piggyback and container) flat cars that are averaging 89 ft long, a situation is created in which these cars can span the detector track circuit at a switch. Hence, to insure that with automatic switching in service a car spanning such a circuit is not derailed by the operation of the switch, presence detectors have been installed. In some of the newer semi-automatic yards, presence detectors have been installed instead of track circuits to prevent unsafe operation of switches.

Two major types (most frequently used) use the rails for a circuit, or use a loop of wire encompassing the switch area. A car entering these circuits distrubs them electrically (unbalances the loop circuit) which indicates car presence. In a few yards, wheel detectors are used in approach to and at the fouling points beyond switches. In such installations, it is a case of counting wheels into and out of the switch area.

High, wide load or clearance detectors, as mentioned earlier, are placed far enough in approach to restricted clearances so that a train with such a load can be stopped prior to reaching the restricted area. Most such detectors simply consist of a light source and a receiving photocell positioned with respect to the source to provide a line of light at the clearance level. For a high load detector this would be a horizontal line of light. For a wide load or side clearance detection problem, several light beams are used so that they pass through points of clearance.

The breaking of the light beam by a high or wide load actuates alarm circuitry to provide audible or visible alarms to alert train crews and/or dispatchers.

ALARM FOLLOWS DETECTION

Once a defect to a moving train or a hazardous condition has been detected, means must be employed to alert the crew of the train, dispatchers, signalmen or track men. Actuation of practically all detectors causes indication lamps to be lighted, alarms to be sounded or automatic block signals to display Stop aspects. Where moving trains are involved, the objective is to alert the engineer so he can bring his train to a stop without applying the brakes in emergency, unless that is required to prevent a derailment.

In many instances, wayside indicator lights, such as flashing lunar-white are used to alert train crews. Where wayside detectors are installed in CTC territory, it is not uncommon to have the actuation of the detector cause an indicator light to be illuminated on the CTC control machine panel. The dispatcher or CTC machine operator may elect to set a controlled signal in the Stop position for the train that had passed the detector. If two-way radio is available, he will radio to the train crew to inform them of the reason for stopping the train. Usually, he will radio the crew immediately upon being alerted by the detector alarm light. Often in this type of action the engineer can bring his train to a stop before he reaches the controlled signal that the dispatcher set against the train.

Until the ICC Rules, Standards and Instructions concerning signal systems were revised—26 rule changes became effective March 31, 1966—dragging equipment detectors where installed in automatic block signal territory had to be interconnected with the block signal system. Thus, actuation of the dragging

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equipment detector would automatically control a wayside signal to the Stop position. One of the revisions was the deletion of Rule 136.602 which required that dragging equipment detectors installed in signal territory be arranged to operate in conjunction with the automatic block signal system.

The reason for deleting this rule is explained in the Commission's order: "The reason for the proposed deletion of the rule in its entirety is that recent technological developments have improved radio communication to such an extent that train crews are informed more promptly of the presence of dragging equipment by radio than by indication of automatic signals. . . .

"Some railroads have made extensive installations of hotbox detectors whereby the information that the train has a hot journal is transmitted by radio either directly to the train crew from the location of the detector or from a central point where the information is rebroadcast to the train. Several of these railroads have elected to install dragging equipment detectors at the same location as the hotbox detectors, so that radio equipment at these locations can also be used to inform the crew of the presence of dragging equipment. . . .

"The Bureau [of Safety and Service] urges that the deletion of this rule will increase safety, rather than decrease it. Part of the support for this position is that when a dragging equipment detector is arranged to operate in conjunction with the automatic signal system, it is required, upon actuation, that the first signal in approach to the signal where train is required to stop will display an approach aspect. Under this arrangement a long train may travel several miles before it is stopped. In the meantime, the dragging equipment may have caused a derailment. On the other hand, if the train crew is informed by radio of the presence of dragging equipment, the train can be stopped immediately, thereby reducing the danger of derailment."

MORE DETECTORS INSTALLED

Many railroads had received relief from this rule when installing dragging equipment detectors in block signal territory. The result of the rule deletion has been to encourage railroads to install detectors in signal territory.

A practice of several railroads with respect to hotbox detectors is to install indicator lamps to alert train crews of the detector actuation. If an overheated journal is detected, a lunar white indicator lamp will start flashing. This lamp is mounted on the mast of the first automatic block signal beyond the hotbox detector scanner. The indicator alerts the train crew of the hotbox. Braking distance beyond this signal will be the hotbox locator readout equipment. Mounted on a signal mast will be an indicator lamp illuminated to show "Hotbox" in white letters. After stopping the train, a crew member will go to the wayside case or bungalow where the readout device will inform him of the location of the hotbox.

Some railroads place an indicator lamp (flashing lunar white or blue) at the detector site. Actuation of the detector caused by the passing train will light this indicator. Timetable information informs crews as to the locations of these detectors and that the crews are to observe the indicators when passing these locations. If the indicator is lighted, the train is to be stopped and inspected.

At these detector sites and at all locations where trains stop for inspection because of actuation of a detector, a telephone is located so the crew can communicate with the dispatcher. They report to him what action they have taken with regard to a detector actuation. On some railroads where radio communication is extensively used (solid train-to-wayside radio coverage is maintained), the crews use radio to contact the dispatcher. In either case, it is essential that the dispatcher be kept informed when a train is stopped because of a detector actuation.

Some railroads which do interconnect detector operation with the automatic block signal system place a special marker plate on the automatic signals that would be controlled to stop by detector operation. This may indicate to the train crew as to the reason for the signal being red. Timetable information would tell them of the type of detector involved, and they could contact the dispatcher for further instructions, as well as informing him of their action. One railroad uses a triangular, black metal marker with a white "P" to indicate that the automatic signal, when displaying the red aspect, may have been so set by a protective device.

DETECTOR ECONOMICS PAY BIG!

With one exception (hotbox detectors), the detectors are comparatively inexpensive in first cost and maintenance. Roads which up to now have not installed these detectors can easily make a few trial installations of each type, and thus secure information on which to base decisions about extensive programs. A complete analysis of numerous local circumstances and number of trains is required when planning to install the protective devices.

A few railroads, when planning to install detectors, make an economic analysis of the traffic handled in the territory under consideration. Factors to be taken into account include number of trains, type of traffic handled, value of this traffic including revenue derived from it, past history of derailments in the territory and the causes, geography of the line under consideration including availability of set off locations, etc. It is a case of balancing costs of detection equipment against the probability of derailments and/or set-offs, and how much such accidents would cost the railroad. This economic analysis approach will probably gain favor because of the availability of computer oriented research procedures for readily making such studies. Most railroads are finding that detectors do pay for themselves.

Even taking the ICC figure of $25,000 for cost of a derailment, most any detector will pay for itself by preventing just one derailment. Considering the more realistic figure for derailment costs of $200,000 to $250,000, then detectors by preventing derailments more than pay for themselves.