

the heads. Sharp bends in the pipe should be avoided and they should be well lagged to reduce radiation.

If a dynamometer car is not used, a stroke counter should be placed at some convenient point in the pilot box to record the revolutions of the drivers. This can be conveniently driven from a finger on the motion rod of the indicator rigging.

To facilitate the working of the men who operate the indicators and read the instruments at the front of the locomotive, and to protect them from wind or rain and jolting, a suitable pilot box extending back to the cylinder and properly secured to the bumper beam should be provided.

Whenever practicable, the bulb of the thermometers used in branch pipe, receiver or exhaust should come in direct contact with the steam and no wells used. When thermometers are placed in wells, they do not respond quickly with the different changes in the working of the locomotive.

The water meters should be attached to the suction pipes of the injectors, and located at points where they can be conveniently read while the locomotive is in motion. Each meter should be provided with a check valve to prevent hot water from flowing through them from the injectors, and strainers to intercept foreign material. With the water scoops it will be impossible to use a float, but when tests are made on roads not using water scoops, a suitable float should be made for determining the water consumption. The water level may be established by using a rubber hose with glass tube inserted in the end, which will indicate the height of water in the tank, this tube to be brought in contact with a properly calibrated scale, or, if more convenient, long glass tubes may be provided at each corner of the tank for the same purpose. In all cases the term "branch pipe" refers to the steam supply pipe to the cylinders and not the injector branch pipe.

OPERATING CONDITIONS AND DURATION. The same operating conditions should be maintained as far as practicable as on a laboratory test. The duration of a test is the running time minus the time the throttle is closed, and depends upon the length of the run between locomotive terminals. In fast passenger service the runs should be, if practicable, at least 100 miles. In service requiring frequent stops and in freight service, the distance may be much shorter. The length of time upon which the hourly rate of consumption and evaporation are based is the total time that the throttle valve is open and not elapsed time between the starting and stopping time.

STARTING AND STOPPING. The fire having been thoroughly cleaned, banked to permit coking, fresh fuel should be supplied to a level thickness which will be required for the run. After the locomotive is attached to the train, observe the pressure, the water level or meter readings, and when the locomotive starts take this as the starting time. Thereafter cover the fire with weighed coal and proceed with the regular work of the test. The ashes and refuse should be removed from the ash pan and smoke box before the locomotive is coupled to the train.

During the run the fire should be maintained in as equal and uniform condition as practicable, and when the end of the route is reached the fire should be as level and approximately the same thickness and condition as at the start. When the locomotive is stopped and the proper level of the fire obtained, the weighed coal should be discontinued. If during the run a stop of over 7 mins. is made, and in order to keep the fire in proper condition, fresh fuel must be supplied; this should be selected from the

unweighed coal. There should preferably be no water supplied to the boiler, and if it is supplied, allowance should be made for same.

On reaching the terminal, the fire being in the same condition as at the start, the water level and water supply should be noted. The time the locomotive comes to rest should be the time of stop of test.

RECORDS. The tests should be in charge of a competent person who is thoroughly familiar with road operations. The number of observers required for a test depends upon the nature of the data to be obtained. When making an efficiency test at least 6 observers should be located on the locomotive, 2 for taking indicator diagrams and any other data that can be taken from the pilot box, 2 for cab data and 2 for coal and water records. It is frequently necessary to increase this force when taking special data. In the dynamometer car at least 4 observers are required, 1 to record the time of each start and stop, passing each station and recording mile posts, points of curvature and tangent and any other important information; 1 to record all information on the diagram and keep track of indicator cards, and 1 to take car numbers and weights of trains; this latter man can also act as a relief observer. When making test of Mallet type of locomotive, the locomotive force is increased to take indicator cards from the low pressure cylinders.

The time to take records depends entirely upon what facilities are available for recording same. If a dynamometer car is available for the tests, records should only be taken when some change in the operation of the locomotive takes place, such as throttle lever, reverse lever and boiler pressure. If the dynamometer car is not available, all records should be taken preferably every 5 mins.

Special reading of the meters and total number of sacks of coal fired should be taken at specified stopping and passing points. Careful observations should be made throughout the run, of the time passing all important points, arriving and leaving each station, and the time that the throttle valve is opened or closed, not only at each stop, but when drifting.

ASH AND REFUSE AND SAMPLING COAL. In weighing and sampling the ash and refuse, the same preparation as described for laboratory tests should be followed as far as practicable. The coal should be sampled while it is being weighed off in 100 lb. lots, and a small proportion taken at different times until about 300 lbs. is obtained. This should be crushed and quartered and about one quart placed in an airtight jar and sent to

chemist for analysis. When this method of sampling is used, care should be taken that the coal does not take on additional moisture, due to leaky cistern or sprinkler. If there is any question as to the coal taking additional moisture after it is once weighed out, sample should be taken from each sack as it is emptied. On all tests the total moisture should be used in all calculations. The same practice as used on laboratory tests for calorific tests of coal should be used on road tests.

DATA AND RESULTS. The data and results should be reported in accordance with the form given for laboratory tests as far as practicable, and in addition a summarized form should be made giving some additional 29 points dealing specifically with the road run as distinct from a laboratory test.

DISCHARGE FROM LOCOMOTIVE SAFETY VALVES. To determine the amount of steam discharged from the safety valves of a locomotive undergoing a road test necessitates the following preparation, as determined by road tests on the Norfolk and Western Rd.:—The outer side of one of the safety valves is drilled and tapped near the top of the muffler for the insertion of a plug (flush with the inside wall of the valve muffler), threaded at each end with a $\frac{3}{8}$ in. pipe thread. The plug forms a conical convergent nozzle having a minimum orifice of 3-32 in. A $\frac{1}{4}$ in. w.i. pipe is run from the plug connection down to the rear of the locomotive cab roof, where a flexible connection, such as a rubber steam hose, is made of sufficient length to reach the bulkhead of the tender. From here a $\frac{1}{4}$ in. pipe is run down along the side of the tender to a point where it is directed into the water compartment and connected to a 1 in. coiled pipe, or condenser, extending down to the bottom of the tank and connecting with a small reservoir located on the outside of the tender frame. Steam, which is admitted to this line when the safety valves lift, is condensed in the coil and collected in the reservoir. A drain cock located at the bottom of the reservoir is used to draw off the condensed steam at the end of each test for the purpose of making the desired calibration. The accuracy of the determination required previously demands a very careful calibration of the safety valve and the orifice, so as to ascertain the exact ratio of steam discharge through the orifice to the total amount of steam discharged through the safety valves. This ratio determined; and the amount of condensed steam passing through the orifice ascertained at the end of the test, the discharge at the safety valves may be calculated for the test period.

Report of Committee on Locomotive Headlights.

The American Railway Master Mechanics' Committee, D. F. Crawford, General Superintendent of Motive Power, Pennsylvania Lines, chairman, presented a very exhaustive report of 330 pages, covering its investigations. A long series of tests were conducted, and in order to thoroughly cover the work the majority of the types of head lights on the market were procured, and additional headlights were assembled, in order to completely cover the range of light intensity from the minimum oil headlight to the maximum electric arc headlight. The investigation was then carried on to determine the desirable and objectionable features of headlights of different intensities, irrespective of the character and source of light, arrangement and design of reflector, etc. In covering this vast amount of work there was an average of twenty

men devoting their whole time to the investigation for five months. All these numerous tests and the methods under which they were conducted, are covered in detail in the report, the observations being depicted graphically on charts. An appendix covers all the recent headlight legislation by the several State legislatures in the United States.

In rating the headlights it was decided to assume as the reference plane the horizontal plane 3 ft. above the rail, ahead of the locomotive, and to consider the intensity of rays striking this plane at various points. All laboratory readings were taken normal to the ray in a vertical plane, 25 ft. ahead of the focal centre, and perpendicular to the axis of the beam. Readings were taken at angles to correspond to stations in reference planes 50, 100, 200, 300,