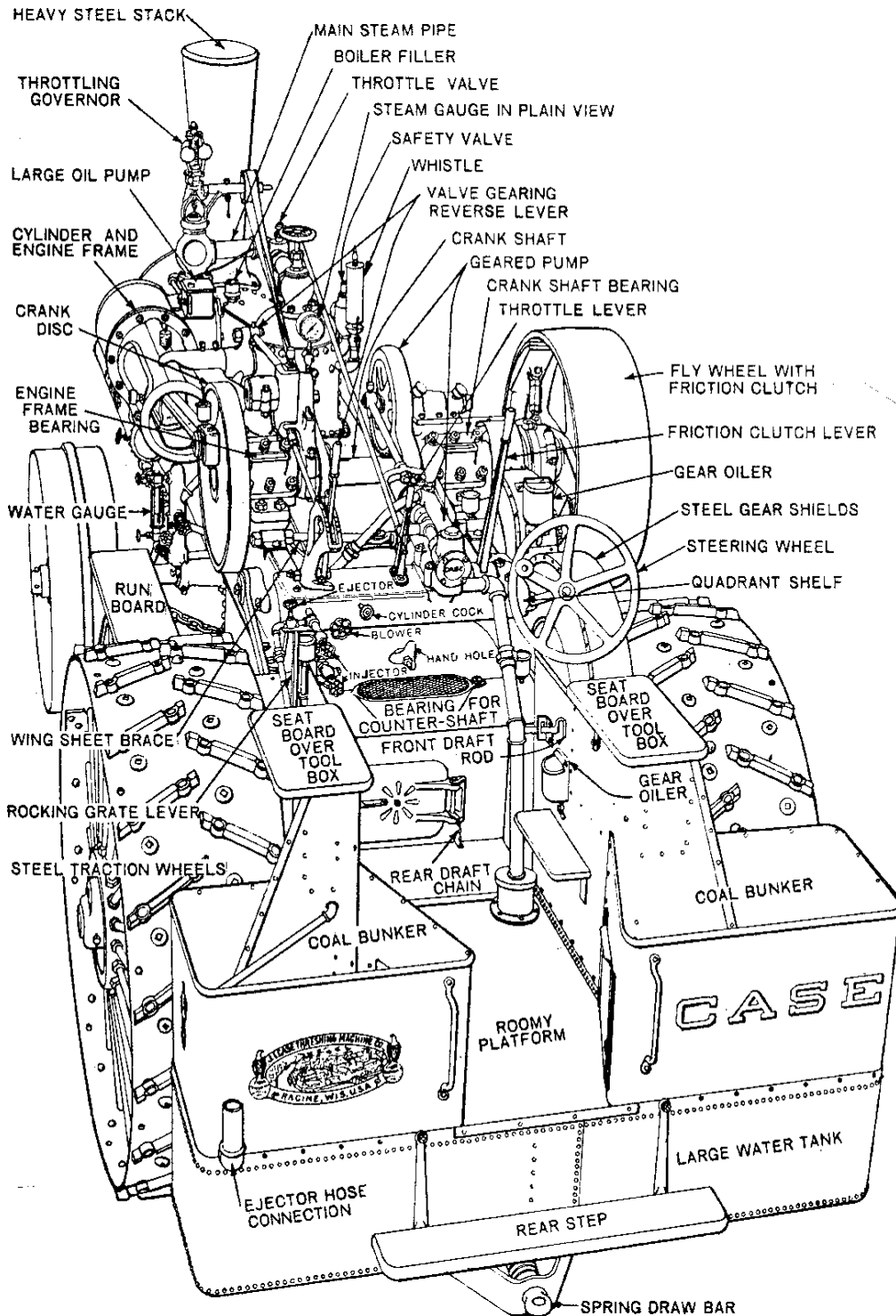


# KANSAS ANTIQUE ENGINE SHOW SAFETY ASSOCIATION

## Appendix 1

# OPERATOR'S TEST

Revision: 2



Revision: 2  
March 2019

GENERAL INFORMATION  
and  
INSTRUCTIONS

In this packet are questions, answers, information and the procedures which the Kansas Antique Engine Shows Safety Association (KAESSA) has prepared for use in qualifying a steam traction engine operator to receive an operator's permit or card. Operators must be 16 years of age. Individuals will provide the examiner documentation that they have a minimum of 50 hours of supervised operation on an engine with a licensed operator. Attendance at the KAESSA Steam School will count as 16 hours toward the 50 hour requirement.

There are four parts to the qualifying procedures. Category I covers terminology and general information that every steam traction engine operator should know. Category II is about boilers and their accessories. Category III covers the engine and its parts. The answers to the questions in the above three categories are to be written. Category IV is the actual performance and demonstration of the skills an operator needs and uses in running a steam traction engine.

This testing and qualifying procedure is to promote learning and safety. It is not an elimination process. It is an "open-book" process; in other words, the person answering the questions can use the general list of answers included in this booklet.

The questions should be completed under the direction of the examiner appointed by your association within 30 days after receiving this packet. The location and time is to be set by mutual agreement. Two hours should be sufficient time for completing questions in categories I, II, and III. Category IV, the actual handling of an engine, will have to be arranged with the examiner to have access to an engine (maybe yours or at least one of your choice) at an appropriate time and location.

The answers to these questions and procedures have a required passing grade of 80% in categories I, II, and III. On category IV all questions and procedures of the ten parts must be marked satisfactory. If a passing performance in any category is not achieved in the first attempt, the testing procedure can be repeated after 30 days.

The examiner that directs this test can be from any Association that is a KAESSA member and at any location. The local Association can make the arrangements that appears to be the best at the time.

CATEGORY I-TERMINOLOGY

The 15 questions below are listed under the heading of General Information and terminology that a good steam traction engine operator should know.

The questions under this heading are printed on this sheet exactly as given in the General list of questions at the back of this packet. Write the answers in the spaces provided under the questions and add any more information you might like to. This is an "Open-Book" test. That means you are permitted to use the answers in the General List when completing the questions, (write on the back if you need more space).

Question #1 What is the purpose of a safety valve or pop-off valve?

Answer # 1

Question # 2 What is low water as applied to a boiler?

Answer # 2

Question # 3 Are there any circumstances under which an engineer is justified in allowing the water to get low?

Answer # 3

Question #4 What causes a boiler to explode?

Answer #4

Question # 5 How rapidly should water be supplied to a boiler?

Answer # 5

Question # 6 What is the difference between priming and foaming in a boiler?

Answer # 6

Question # 7 What danger is there when water foams badly? what if it primes badly?

Answer # 7

Question # 8 If an engine exhausts liquid water from the stack, what may be the cause?

Answer # 8

Question # 9 What is meant by dead center?

Answer # 9

Question # 10 What is steam?

Answer # 10

Question # 11 Can you vary or regulate to a great extent the amount of water an injector will put out?

Answer # 11

Question # 12 What are the two kinds of draft to regulate the fire in a steam traction engine boiler?

Answer # 12

Question # 13 How is water forced into a boiler while the boiler is under steam pressure?

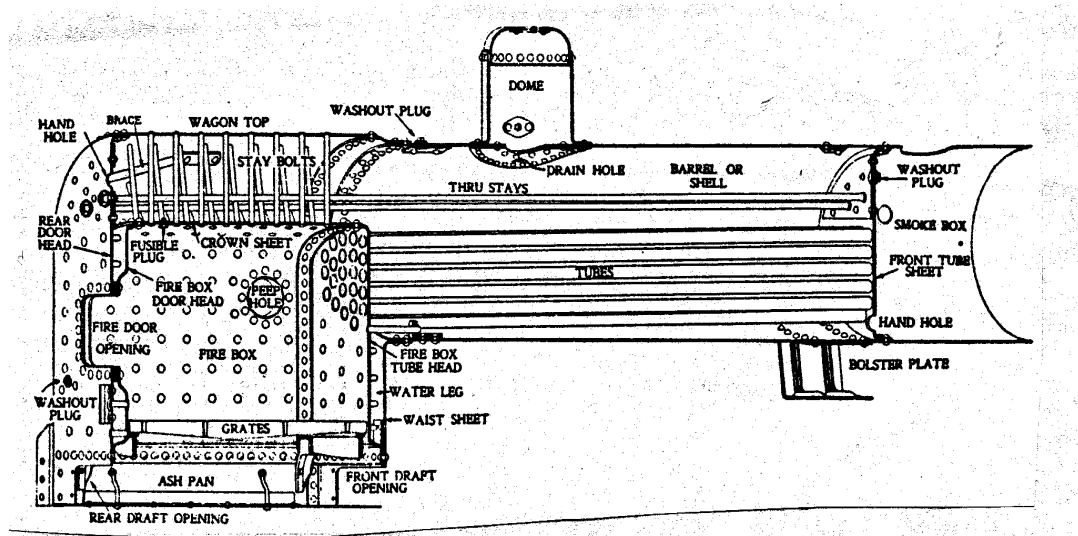
Answer # 13

Question # 14 Why clean flues and how?

Answer # 14

Question # 15 Is it necessary that a boiler have a pressure gauge and how is it hooked up?

Answer # 15



CATEGORY II BOILERS AND ACCESSORIES

The 15 questions below concern the correct operation procedures and tests to use on boilers and the necessary accessories that are on steam traction boilers.

The questions under this heading are printed on this sheet exactly as given in the General list of questions at the back of this packet. Write the answer in the space provided under the questions and add any more information you might like to. This is an "Open-Book" test. This means you are permitted to use the answers in the General List when completing the questions. (Write in back if more space is needed)

Question # 1 How should the blower be used?

Answer # 1

Question # 2 What is the result of opening the fire-door when the engine is working hard?

Question # 2

Question # 3 How do you check the water level in a boiler?

Answer # 3

Question # 4 Would it be advisable to put water into a boiler after the sheets have become bare and maybe red-hot?

Answer # 4

Question # 5 What is one of the most important things to do to the engine the first thing in the morning?

Answer # 5

Question # 6 Should the water glass show  $\frac{1}{4}$ ,  $\frac{1}{3}$  or above  $\frac{1}{2}$  glass of water to be safe?

Answer # 6

Question # 7 How often should safety or pop-off valve be checked?

Answer # 7

Question # 8 To be safe and to be in compliance with most regulations, what boiler accessories should every boiler have besides the steam gauge, pop-off valve, the soft plug and the water glass and tri-cocks?

Answer # 8

Question # 9 Which is most reliable under most conditions, the water glass or trycocks?

Answer # 9

Question # 10 What is the purpose of the fusible plug or soft plug?

Answer # 10

Question # 11 Is priming and foaming the same?

Answer # 11

Question # 12 Suppose that the water glass is in good condition, immediately after closing the throttle, water disappears from the water glass. What should be done?

Answer # 12

Question # 13 What range of boiler pressure is required to start a regular injector?

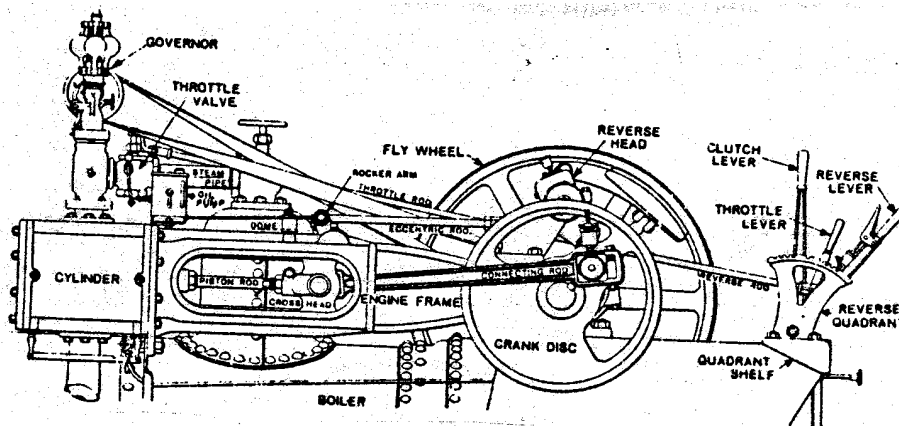
Answer # 13

Question # 14 When is it best to test the pop-off valve?

Answer # 14

Question # 15 How much pressure is used on a hydrostatic test?

Answer # 15



### CATEGORY III ENGINE AND PARTS

The 10 questions given below concern the Engine and its parts and the proper procedures to insure safety, provide good maintenance and to get good performance.

The questions under this heading are printed on this sheet exactly as given in the General list of questions at the back of this packet. Write the answer in the space provided under the question and add any more information you might like to. This is an "Open-Book" test. This means you are permitted to use the answers in the General List when completing the questions. (Write in the back if more space is needed)

Question # 1 Before rolling the engine, after enough pressure shows, what is the most important thing to do first?

Answer # 1

Question # 2 How should the engine be run at first?

Answer # 2

Question # 3 Why should the ash pit be kept clean?

Answer # 3



Question # 4 Which way is the engine crank-plate or band wheel turning when running 'over'?

Answer # 4

Question # 5 Name five safety devices on a boiler while the boiler is under steam pressure?

Answer # 5

Question # 6 What could be the trouble if the governor jumps or is irregular?

Answer # 6

Question # 7 How do you get a single cylinder engine running in the direction you want?

Answer # 7

Question # 8 Is steam cylinder oil good to use for lubricating other moving parts on the engine?

Answer # 8

Question # 9 What do you do when the water does not show in the glass?

Answer # 9

Question # 10 Probably what is the most important duty of a boiler operator?

Answer # 10

CATEGORY IV

DEMONSTRATING OPERATION of a STEAM TRACTION ENGINE

The written questions in categories I, II, and III must be completed before performing the 10 procedure/questions in this category # IV.

This part of the testing procedure must be done on a "Hot Engine" that is, carrying a boiler pressure in the safe range of the boiler. The supervisor or examiner shall call for Procedure/Questions exactly as listed below. He will observe the applicant's performance/skill as applied to each question. He shall give no instructions nor help except in emergencies. He will record each procedure/question as either "Satisfactory" or "Unsatisfactory". There are 10 parts in this section and all must receive a rating of "satisfactory" to be approved in Category IV.

\*Procedure/Question # 1 Demonstrate the use of the try-cock to show water level in a boiler.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/Question # 2 Demonstrate use of injectors and pumps to actually supply feed-water to the boiler.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/Question # 3 Call the direction the engine will turn when reverse lever is set and before opening throttle.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/Question # 4 Show how to properly "throw a fire" or in other words, show how to shovel coal on the fire.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/question # 5 Demonstrate some different ways to prevent a single cylinder engine from stopping on "dead center".

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/question # 6 Demonstrate backing traction engine into a traction load and getting into the belt.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/question # 7 Demonstrate holding, slowing or stopping an engine going up or down grade with a load.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

'Procedure/question # 8 Demonstrate how and explain what should be checked carefully when getting on or taking over the operation of an engine.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/question # 9 Demonstrate correct checking of safety, or commonly called, pop-off valve.

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

\*Procedure/question # 10 Demonstrate the correct whistle signal for:  
Starting engine in any way.  
For stopping.  
For backing up.  
Calling for water.  
Calling for the boss's help.  
Emergency (like fire).

Witness By \_\_\_\_\_ Date \_\_\_\_\_ Insp \_\_\_\_\_ Phone \_\_\_\_\_

#### INFORMATION AND SKILLS THAT MAY BE ASKED BY LICENCING INSPECTOR

1. Describe how to prepare engine for Hydro and Ut inspections.
  - Pulling grates.
  - Pulling/installing handholds.
  - Removing and inspecting the fusible plug.
2. How to prepare a boiler for steaming and operation.
  - Visually inspect boiler inside and out.
  - Install grates and handholds.
  - Fill with water.
  - Build a fire.
  - Check oilers and fill.
3. Identify the maximum operation pressure on a engine.
4. Describe what actions to take safely in the case of the site glass being broken.
5. Blow down boiler.
6. Describe emergency shutdown procedures.
7. Describe procedures to shut down and steps to take when leaving a hot engine overnight.
8. Drain and prepare engine for storage.

RECORD

The applicant for a Steam Traction Engine Operators Card shall fill out the form below.

APPLICATION DATE \_\_\_\_\_

APPLICANT'S NAME \_\_\_\_\_ AGE \_\_\_\_\_ Date of Birth \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

PHONE with area code \_\_\_\_\_ E-Mail \_\_\_\_\_

Member's association \_\_\_\_\_

TYPE OF ENGINE TO BE USED IN CATEGORY IV DEMONSTRATION \_\_\_\_\_

-----  
The Examiner only will fill out and sign the form below at the completion of all tests and demonstrations.

EXAMINER'S NAME \_\_\_\_\_

ADDRESS \_\_\_\_\_

CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

Examiner's Association \_\_\_\_\_

\_\_\_\_\_ GRADE OF ABOVE APPLICANT----- CATEGORY I

\_\_\_\_\_ GRADE OF ABOVE APPLICANT---- CATEGORY II

\_\_\_\_\_ GRADE OF ABOVE APPLICANT---- CATEGORY III

PERFORMANCE OF ABOVE APPLICANT IN CATEGORY IV

[ ] SATISFACTORY

[ ] NOT SATISFACTORY

YES [ ] NO [ ] DID APPLICANT COMPLETE THE REQUIRED 50 HOURS OF SUPERVISED OPERATION?

YES [ ] NO [ ] IS THE ABOVE APPLICANT APPROVED BY EXAMINER?

DATE OF APPROVAL \_\_\_\_\_

**Send only this completed page and the Practical test score sheet (Category IV) to the KAESSA Secretary for the operator's license number assignment.** These Records shall be kept on permanent file with KAESSA. The applicant may keep the test sheets. The operator's license signed by KAESSA President and be mailed to the successful applicant by the KAESSA Secretary.



## THE GENERAL LIST OF QUESTIONS AND ANSWERS

This list is not in a logical order and the questions are not grouped. Some questions are duplicated or nearly so. Some questions may be very difficult or not related. It was the thought by the Committee to use these questions as a familiarization to commonly used steam traction engine terms, as a learning experience and as a test. It could also incur some debate and differences of opinion. All questions are documented.

1. **WHAT PRESSURE IS INDICATED BY A STEAM GAUGE?** The pressure per square inch inside the boiler.
2. **ON WHAT PRINCIPLE DOES THE STEAM GAUGE WORK?** The steam gauge pointer is actuated by a flattened bent tube which tends to straighten under pressure of the steam. The gauge pointer receives movement from a suitable mechanism connected with the tube.
3. **WHAT IS THE SOURCE OF POWER IN A STEAM ENGINE?** Heat.
4. **ABOUT WHAT QUANTITY OF WATER WILL BE EVAPORATED IN A GOOD BOILER FOR EACH POUND OF COAL?** From 5 to 7 gallons of water. (100 pounds of coal should evaporate 60 to 84 gallons of water.)
5. **WHAT WOULD INDICATE THE BOILER CONNECTIONS OF WATER GAUGE GLASSES WERE BECOMING CLOGGED?** The movement of water in the glass would become slow and inactive or it might not register with gauge cocks (tri-cocks).
6. **WHAT HAPPENS WHEN COAL IS THROWN ON THE FUEL BED IN A FIREBOX?** Coal, when thrown, instead of producing heat at once absorbs some heat from the fire, which tends to break down the coal structure into its various elements. Then these elements can unite with oxygen of the air and burn, producing heat.
7. **HOW MANY CUBIC FEET OF AIR ARE NECESSARY TO BURN A POUND OF COAL?** Theoretically, approximately 300 cubic feet of air are required to provide oxygen necessary for the combustion of one pound of coal.
8. **WHAT IS THE IGNITION TEMPERATURE OF COAL?** For average bituminous coal, the ignition temperature is approximately 1800° F.
9. **WHAT FIREBOX TEMPERATURE MAY BE DEVELOPED IN A COAL BURNING BOILER?** With the boiler drafted and fired properly, the temperature of the gasses at the center of the firebox will range between 2000 and 2800° F., depending of course on the type of boiler, quality of coal fired and rate of work.
10. **HOW SHOULD THE BLOWER BE USED?** The blower should be used as lightly as possible, being careful not to draw too much cold air into the firebox or through the flues, especially when the fire bed is thin or when fire is being cleaned.
11. **WHAT IS THE RESULT OF OPENING THE FIRE DOOR WHEN THE ENGINE IS WORKING HARD?** It will cause a cooling effect in the firebox and is liable to cause flues to leak.

12. HOW CAN A FIRE BE MAINTAINED IN A GOOD CONDITION? By spreading fuel thinly and uniformly over the entire fire bed, adding coal at a rate no faster than it is being burned.
13. WHAT IS THE PURPOSE OF A SAFETY VALVE OR POP-OFF VALVE? A safety valve is used to limit maximum pressure in boiler by opening and allowing steam to escape.
14. WHAT IS THE CAUSE AND EFFECT OF CLINKERS? Clinkers are caused by permitting the fire to melt the ash followed by cooling of the molten ash into a clinker. A clinker seals off an area of the grate surface and will not permit flow of air through that portion of the grates.
15. WHAT WOULD BE CONSIDERED ABUSE OF A BOILER? Careless supplying of water to boiler, improper firing, excessive use of fire door, allowing steam to vary from high pressure to low pressure, causing unnecessary expansion and contraction.
16. HOW DO YOU CHECK THE TRUE WATER LEVEL IN A BOILER? Try gauge cocks (trycocks). Check top and bottom water glass valves to see if they are open. Blow out water glass by opening drain valve at bottom of water glass, then close drain valve and see if level of water level in glass matches the trycocks.
17. HOW MUCH WATER SHOULD BE CARRIED IN A BOILER? Not more than 3 gauges or not less than 1 gauge.
18. HOW MAY MORE POWER BE OBTAINED FROM AN ENGINE? By reason of increased boiler capacity, an engine may work further down before a steam failure occurs.
19. WHY ARE BOILERS PROVIDED WITH STEAM DOMES? To furnish more steam space and to obtain dryer steam and to provide a place for safety valves, steam pipes, throttle valve, whistle, etc.
20. WHAT MUST BE THE CONDITION OF THE BOILER TO GIVE THE BEST RESULTS? It must have good circulation and be clean and free from mud and scale.
21. WOULD IT BE ADVISABLE TO PUT WATER INTO A BOILER AFTER SHEETS HAD BECOME BARE AND PERHAPS RED HOT? No. The fire should be smothered as soon as possible.
22. WHAT OBJECT IS THERE IN HAVING EXHAUST STEAM GO THROUGH THE STACK? To create a draft through the tubes and fire box.
23. WHAT CAUSES "PULL" ON THE FIRE BOX DOOR? The partial vacuum in the front end; when excessive it indicates fire clinkered or insufficient opening for admission of air under fire.
24. DESCRIBE PRINCIPLE UPON WHICH THE INJECTOR WORKS. The action of injector is due first to difference between "kinetic" or moving energy and "static" or standing energy; second, the fact that steam under pressure travels at very high speed and velocity and when placed in contact with stream of water it is condensed into water, and at the same time imparts enough velocity to the water to give it sufficient momentum to overcome pressure even greater than original pressure of steam. By imparting this velocity to water it gives sufficient energy to throw open the boiler check valve and enter the boiler.
25. DEMONSTRATE THE CORRECT WHISTLE SIGNAL FOR: STARTING THE ENGINE IN ANY WAY; STOPPING; BACKING UP; CALL FOR WATER; CALL FOR THE BOSS'S HELP; AND EMERGENCY (LIKE FIRE). Starting - two shorts; stopping - one short; backing up - three shorts; call for

water - three longs; boss's help - four longs; emergency - one long and four shorts (should be repeated in right sequence until attention has been gained by those concerned).

26. WHAT IS ONE OF THE MOST IMPORTANT THINGS TO DO TO THE ENGINE THE FIRST THING IN THE MORNING? Check the water level.

27. SHOULD THE WATER GLASS SHOW 1/4, 1/3, OR ABOVE 1/2 GLASS OF WATER TO BE SAFE? The water level must be at least 2 1/2 inches over the crown sheet. Typically, this is 1/4 of the water glass.

28. BEFORE ROLLING THE ENGINE OVER, AFTER ENOUGH PRESSURE SHOWS, WHAT IS IMPORTANT TO DO FIRST? Open the cylinder cocks.

29. HOW SHOULD THE ENGINE BE RUN AT FIRST? Either by rocking back and forth or run slowly.

30. HOW OFTEN SHOULD SAFETY OR POP OFF VALVE BE CHECKED? At least once a day.

31. TO BE SAFE AND TO BE IN COMPLIANCE WITH MOST REGULATIONS, WHAT BOILER ACCESSORIES SHOULD EVERY BOILER HAVE BESIDES THE STEAM GAUGE, POP-OFF VALVE, SOFT PLUG, AND THE WATER GLASS AND TRYCOCKS? Either 2 injectors, or an injector and a pump.

32. HOW DO YOU DETERMINE HOW MUCH WATER IS STILL OVER THE CROWN SHEET WHEN IT JUST DISAPPEARS FROM THE GLASS? Before filling the boiler the first time and with the engine reasonably level, and with the rear hand hold plate removed, fill the boiler until water just shows in glass, then measure the depth of water at or near the soft plug.

33. IF THE WATER GLASS BREAKS, CAN THE ENGINE CONTINUE TO BE USED? Yes. Water level can be determined by use of trycocks.

34. WHICH IS MOST RELIABLE UNDER MOST CONDITIONS, THE WATER GLASS OR TRYCOCKS? Trycocks.

35. HOW OFTEN SHOULD THE TRYCOCKS BE USED? Often enough to know they are in operating condition and are not liming over and to test accuracy of water in glass.

36. AFTER BEING AWAY FROM THE ENGINE FOR SOME TIME, AS OVERNIGHT, NOON, OR OTHER REASONS, WHY SHOULD THE VALVES ON THE WATER GLASS BE CAREFULLY CHECKED? To be sure that one or both have not been closed and showing incorrect level.

37. WHEN AN INJECTOR THAT HAS BEEN WORKING PROPERLY SUDDENLY REFUSES TO START WHAT SHOULD BE CHECKED? Check the injector for being hot, as from a leaky check valve at the boiler or the steam valve not closed tightly, then check water level in supply tank for being out of water or too hot.

38. SHOULD FEED WATER FROM A GEARED OR CROSSHEAD PUMP BE FORCED DIRECTLY INTO THE BOILER? No. The water should go through a heat exchanger first.

39. WHAT IS THE PURPOSE OF THE SYPHON OR PIGTAIL BETWEEN THE BOILER AND STEAM GAUGE? To keep live steam from coming in contact with the gauge.



40. WHAT IS THE PURPOSE OF THE- FUSIBLE PLUG OR SOFT PLUG?

To protect the crown sheet when water is allowed to get too low. When it melts out the steam in the boiler is directed on the fire to kill it down.

41. IS PRIMING AND FOAMING THE SAME? No. Priming may be caused by high water. Foaming from impurities in the water.

42. SOME TIMES AFTER STARTING A FIRE IN THE BOILER, MOISTURE WILL APPEAR-ON THE TUBE SHEETS, FLUES, AND SIDE WALLS, AND EVEN DRIP FROM THE FIRE BOX. WHAT IS THE CAUSE FOR SUCH WATER TO SHOW UP? Condensation or sweating. It is due to atmospheric conditions and is not harmful.

43. DEFINE THE HEAT UNIT KNOWN AS THE BRITISH THERMAL UNIT. The amount of heat required to raise the temperature one degree Farenheit of 1 pound of water.

44. WHAT IS THE PURPOSE OF THE GOVERNOR? To control engine speed at a specified r.p.m. In other words it regulates engine speed when the throttle is wide open, thus freeing the engineer.

45. IN THE TIME INTERVAL BETWEEN BECOMING AWARE THE INJECTOR IS NOT WORKING AND THE POSSIBLE NECESSITY OF SMOTHERING THE FIRE, WHAT CAN BE DONE TO HELP ALLEVIATE BOILER DAMAGE. PUTTING IT ANOTHER WAY, THE LOGICAL THING TO DO WHILE TRYING TO GET THE INJECTOR TO WORK? Move engine to position that rear end is lower than the front. This puts water over the crown sheet longer.

46. WHAT IS LOW WATER AS APPLIED TO A BOILER? It is when the water is insufficient to cover all parts exposed to the flames.

47. ARE THERE ANY CIRCUMSTANCES UNDER WHICH AN ENGINEER IS JUSTIFIED IN ALLOWING THE WATER TO GET LOW? No most of the time. Yes, when approaching a very steep long hill.

48. WHAT WOULD BE THE FIRST DUTY OF AN ENGINEER ON DISCOVERING THAT THE WATER WAS FOAMING OR PRIMING? Open the cylinder cocks at once and throttle the steam. This lets the water out of the cylinder and allows the water to settle in the boiler.

49. WHAT IS THE STROKE OF AN ENGINE? It is the distance the piston travels in the cylinder.

50. WHAT CAUSES A BOILER TO EXPLODE? An explosion occurs generally from low water, allowing the iron to become overheated and thereby weakened and unable to withstand pressure.

51. WHERE IS THE FUSIBLE PLUG GENERALLY LOCATED IN A BOILER? A safety or fusible plug is a hollow plug or bolt screwed into the crown sheet or top of the fire box. It melts when heated above a certain point.

52. WHAT IS A BALANCED VALVE? A valve in which the steam pressure is the same on all of its area.

53. WHAT IS A SLIDE VALVE? Generally known as a "D" type valve. It slides over the ports.

54. WHAT IS AN ECCENTRIC? A device to control valve action.

55. WHAT IS A COMPOUND ENGINE? Consists of an engine with a small cylinder and a larger cylinder. Steam that is exhausted from the small cylinder is used again in the larger cylinder.
56. WHAT ARE TWO KINDS OF COMPOUND ENGINES? Tandem compound and cross compound.
57. WHAT ARE THE NAMES OF SOME VALVE GEARS USED ON STEAM TRACTION ENGINES? Marsh, Grimes, Stephenson, Woolf, etc.
58. WHAT IS A HYDROSTATIC LUBRICATOR? Uses steam and water to force lubrication into the flow of steam to the engine.
59. WHAT IS A ROCKER GRATE? Grates so hooked up and mounted in the fire box that the operator can rock them to cause them to change position enough to allow ashes to fall through.
60. WHAT IS A BOILER "WATER LEG"? At the lower part of the boiler next to the fire box.
61. DESCRIBE A "WATER BOTTOM" BOILER. Water completely surrounds the ash pit.
62. IF STEAM OR WATER SHOWS AT OVERFLOW PIPE WHEN INJECTOR IS NOT WORKING, HOW CAN YOU TELL WHETHER IT COMES FROM BOILER CHECK OR THROUGH STEAM CONTROL VALVE? Close the main steam valve at boiler. That will stop leak if it comes from steam control valve.
63. WHY NOT HEAT WATER TO 150 OR 200 DEGREES BEFORE IT GOES TO THE INJECTOR? If the feed water is heated very much above 100°, it will not condense enough steam in the injector to cause it to work properly. Some injectors will work hotter water than others.
64. HOW MUCH OIL OR HOW MANY DROPS PER MINUTE SHOULD ORDINARILY BE FED TO VALVES AND CYLINDERS? Only sufficient amount to maintain a bright film of oil on valve stems and piston rods.
65. WHAT IS SATURATED STEAM? Steam that has not been heated over 100° above its generating point.
66. WHAT IS SUPERHEATED STEAM? It is saturated steam from water from which it was generated with more heat added, increasing its temperature from 100° to 250° above saturated steam of any given pressure.
67. WHAT IS MEANT BY WORKING STEAM EXPANSIVELY? Placing reverse lever toward center (hooking-up) gives valve a shorter travel and closes live steam port when piston has made only part of its stroke. This cuts off live steam from the steam chest. The expansion of steam already in cylinder pushes piston to end of stroke without use of a full cylinder of live steam.
68. HOW RAPIDLY SHOULD WATER BE SUPPLIED TO A BOILER? No faster than it is evaporated into steam, unless just before a hard pull or when shutting off with heavy bright fire in the fire box to prevent waste of steam at pops off.
69. WHAT IS THE DIFFERENCE BETWEEN PRIMING AND FOAMING IN A BOILER? Priming is caused by carrying water too high in boiler so that when throttle is opened some of it passes over with the steam in the form of spray. Foaming is caused by water becoming dirty from animal or alkaline matter, so that heat makes it foam like soap suds. Muddy water or certain vegetable matters will also make a boiler foam.

70. WHAT SHOULD AN OPERATOR DO IN CASE OF FOAMING? If possible allow boiler to cool off a little, increase supply of feed water to prevent water getting too low and whenever possible blow some of the dirty water out of boiler replacing it with clean water.
71. WHAT SHOULD AN OPERATOR DO IN CASE OF PRIMING? Lighten the load if possible and shut off supply of feed water until water level drops to proper height in boiler.
72. WHAT DANGER IS THERE WHEN WATER FOAMS BADLY? WHEN IT PRIMES BADLY? There is danger of knocking out cylinder heads, cutting valves, stalling under the load because the engine cannot be worked to its proper power. When shutting off steam, water is liable to drop below crown sheet and thus risk burning the fire box. When water primes badly, it is liable to break cylinder, packing rings, knock out cylinder heads, break bolts in the steam chest and cut valves. In such a case, additional oil should be fed to steam chest until valves are properly lubricated again.
73. SUPPOSE THAT WITH WATER GLASS IN GOOD WORKING ORDER, IMMEDIATELY AFTER CLOSING THROTTLE WATER DISAPPEARED FROM WATER GLASS, WHAT SHOULD BE DONE? If the operator does not know the water level, the fire should be smothered as soon as possible. The fire should never be raked out, only smothered with dirt or sand. If the operator knows the water level is sufficient to cover the crown sheet, the operator should open the throttle again and endeavor to raise water with the injector or pump to put enough water in the boiler to make it entirely safe to close throttle.
74. WHY IS IT SO NECESSARY TO KEEP CYLINDERS FREE FROM WATER? In order to keep from damaging valves and cylinders, to insure better lubrication thereby obtaining more efficient service from engine and fuel.
75. WHAT CONSTITUTES ABUSE OF AN ENGINE? Improper use of injector by filling boiler at a rapid rate unless you have heavy bright fire to heat injected water to boiler temperature as fast as it comes into the boiler. Excessive use of blower, especially with a light fire or when cleaning fire. Improper attention to machinery, such as keeping parts properly lubricated, bearings not properly adjusted, carrying too much or not enough water in the boiler, working water through cylinders, running too fast (high r.p.m. governor settings).
76. IF AN ENGINE EXHAUSTS LIQUID WATER FROM THE STACK, WHAT MAYBE THE CAUSE? Water in the boiler carried at too high a level. Slow leak at the blower valve. Boiler foaming. Feed water tube leaking. Condensation when first starting in the chest and cylinder.
77. WHAT IS A STEAM CHEST? It is an enclosed steam chamber in which a valve is operated.
78. WHAT IS A PORT? It is an opening between steam chest and cylinder, over which a valve is operated.
79. WHAT IS A VALVE? It is a sliding mechanism or member through movement of which admission and exhaust of steam to each end of cylinder is controlled.
80. WHAT IS VALVE GEAR? It is the mechanism employed for actuating or moving the valve.
81. WHAT IS MEANT BY DEAD CENTER? The position of the crank plate or driving wheel when a straight line from center of a wrist pin in a cross-head, through center of crank plate, intersects center of main pin or bearing.

82. **IN GETTING UP STEAM, HOW SHOULD THE OPERATOR PROCEED?** First he should find out if the water is at a proper level (use trycocks for this purpose), remove all ashes and cinders from the fire box, and then cover the grates with a thin layer coal. He should then place the wood and tinder on the coal, after which he can start the fire.

83. **WHY IS IT ADVANTAGEOUS TO PLACE A COAL COVERING ON THE GRATES BEFORE PUTTING ON WOOD AND TINDER?** It protects the cold grates and bars from the heat of the fire and it saves fuel, since the heat that would be transmitted to the bars is absorbed by the coal.

84. **HOW SHOULD THE OPERATOR REGULATE THE FIRE?** He should keep the fire at a uniform thickness over all parts of-the-grates, not allowing any bare spots or any accumulation of ashes nor dead coals at any part of the fire box; he should then supply the coal in small quantities at frequent intervals. He should avoid excessive firing as much as possible.

85. **HOW THICK SHOULD THE FIRE BE?** Thick enough to keep a good bed of coals and thin enough to let enough draft through evenly over all the grate surface.

86. **WHY SHOULD THE ASH PIT BE KEPT CLEAN?** If allowed to fill up with ashes and cinders, the grate bars will become overheated and may be either badly warped or burned because there was no draft to keep them cool.

87. **HOW OFTEN SHOULD THE OPERATOR CLEAN THE BOILER?** Once a week if the water is clean. If it is from rivers or ponds, it may need to be cleaned more often.

88. **WHAT IS SCALE IN A BOILER?** It is a deposit that forms on the inside of the boiler and tubes. It comes from the impurities in the water. The use of a good boiler compound will help to keep the lime from corroding the inside of the boiler.

89. **WHAT IS STEAM?** Steam is the vapor of water. It is colorless, expansive fluid. The white cloud issuing from an exhaust pipe, usually called steam, is not steam but in reality is a fog of minute liquid particles produced by condensation.

90. **WHAT IS MEANT BY DRAWING THE FIRE?** Drawing the fire consists of pulling the fire out of the fire box with the hoe. In case the water gets dangerously low in the boiler, the fire should be smothered with dirt, sand or a non-combustible material. A fire should not be drawn without first being "killed" by smothering. Never put water in the fire box to put out the fire, as it is not only liable to crack the grates but will turn into steam and blow some of the fire out through the fire door.

91. **WHAT CAUSES GRATES TO BURN OUT?** The ash pit should always be kept clean in order to give a free passage for air to the fire and prevent the grates from burning out.

92. **IS IT NECESSARY TO USE THE BLOWER WHEN THE ENGINE IS RUNNING?** The blower should be used only when the engine is not running. When the engine is running it exhausts through the exhaust which answers the same purpose as the blower.

93. **WHAT IS THE MOST ECONOMICAL FEED WATER SYSTEM?** A geared pump run from the engine, feeding through a feed water heater. Injectors are not as efficient.

94. WILL ANY TYPE OF FEED WATER SYSTEM HANDLE HOT WATER? No pump will lift hot water, as it is difficult to produce a vacuum above it. As soon as air is removed, the water gives off steam or vapor which fills the suction pipe above it.
95. WHAT CAUSES WATER AT THE STACK? Engine priming or foaming. Condensation in the feed water heater. Leaky blower valve. At first it might be condensation in the cylinders or steam chest.
96. IS THE PRESSURE IN A BOILER THE SAME ALL OVER? There is slightly more pressure on the bottom of a boiler (due to the weight of the water in the boiler) than there is steam pressure on the top.
97. WHAT IS THE PURPOSE OF THE OVERFLOW VALVE ON AN INJECTOR? When steam is first turned on to the injector, it does not have sufficient force to raise water and force itself into the boiler, but passes through the body of the injector and escapes through the overflow valve. In doing this it creates a partial vacuum in the suction pipe until it reaches the steam jet, where it mixes with the steam. The steam then condenses, mingles with the cold water and imparts velocity to it. When the right proportions of water and steam are received by the injector, it will impart sufficient velocity to the jet of water passing through the combining tube to enable it to raise the check valve and force water into the boiler. As soon as this occurs, it produces a vacuum in the body of the injector around the combining tube and the overflow will close. A shorter answer is the overflow is to provide an outlet for steam and water when they are not mixed properly or when there is not sufficient force to the jet of water to cause it to flow into the boiler.
98. CAN YOU VARY OR REGULATE TO A GREAT EXTENT THE AMOUNT OF WATER AN INJECTOR WILL PUT OUT? That is another objection to injectors. Although an injector has a range of operation where the ratio of inlet water and steam can be varied, they cannot be regulated to the same range as a pump, where a very slow rate can be achieved. Injectors must feed to nearly their full capacity or not at all.
99. WHAT RANGE OF BOILER PRESSURE IS REQUIRED TO START A REGULAR INJECTOR? It usually requires from 30 to 80 pounds of steam to start an injector, depending upon the height it has to draw the water. When the injector is in operation the pressure may often be lowered to 10 or 15 pounds before it will stop working. There are three pressure ranges of injectors, low, medium and high.
100. WHAT IS A GOOD WAY TO CLEAN SCALE OUT OF AN INJECTOR? Scale may be removed by letting the injector soak over night in a solution of one part muriatic acid and ten parts of water.
101. WHAT IS THE MAIN DIFFERENCE BETWEEN A SLIDING "D" VALVE AND A BALANCED VALVE? On a simple engine with the plain "D" slide valve, considerable energy is consumed in moving the slide valve back and forth upon its seat, due to the steam pressure in the steam chest upon the back of the slide valve. The balanced valve has no back pressure on it from the steam in the chest.
102. WHICH WAY IS THE ENGINE CRANK PLATE OR BAND WHEEL TURNING WHEN RUNNING "OVER"? When the top of the crank plate moves away from the top of the cylinder, the engine is said to be running ahead or "over".
103. WHICH WAY IS THE ENGINE CRANK PLATE OR BAND WHEEL TURNING WHEN RUNNING "UNDER"? When the top of the band wheel moves backwards towards the top of the cylinder, the engine is said to be running backwards or "under".
104. WHAT IS A SIMPLE ENGINE? A simple engine with a cylinder in which the steam being used in the cylinder pushes the piston and then escapes through the exhaust. It works on both ends of the cylinder.

105. **WHAT IS A COMPOUND ENGINE?** In a compound engine the cylinders are not of the same size, but each successive cylinder must be larger. The steam from the boiler first enters the smallest cylinder, called the high pressure cylinder. After having pushed the piston to the end of the stroke, it exhausts into the next cylinder, which is larger, and so on until it has pushed the piston in each cylinder.

106. **WHAT ARE SOME OF THE DIFFERENT KINDS OF COMPOUND ENGINES?** Tandem compound and cross compound are the most common that are used on traction engines.

107. **WHEN IS IT BEST TO TEST THE POP-OFF VALVE?** When the steam pressure has risen approximately 75% of the rated pressure, the safety valve should be pulled open by hand in order to be sure that it is not stuck on its seat.

108. **WHAT ARE THE CHARACTERISTICS OF GOOD STEAM CYLINDER OIL?** The cylinder oil (600-W) must be of such nature as to stand the heat in the steam chest and cylinder. If engine oil is used for this purpose, the action of the heat would decompose it, and it would lose its lubricating quality.

109. **HOW MAY THE HORSE POWER OF AN ENGINE BE INCREASED?** If the boiler is adequate, by raising the steam pressure. The other manner of increasing power would be to increase the piston speed or the number of r.p.m.

110. **WHAT IS THE STANDARD HORSE POWER RATING FOR STEAM BOILERS?** It is the evaporation of 30 pounds of water per hour from a feed water temperature of 100° F, into steam at 70 pounds of gauge pressure.

111. **ABOUT WHAT WOULD BE THE TEMPERATURE OF A CHERRY RED FIRE?** Close to 1650° F.

112. **WHAT IS THE BOILING POINT OF WATER?** It depends upon the pressure. In an open kettle, at sea level, water boils at 212° F. If contained in a closed boiler, the boiling temperature will rise when the steam pressure rises. If a vacuum is produced, the water will boil at less than 212° depending on the vacuum secured.

113. **WHAT IS THE TEMPERATURE OF STEAM AT 100 POUNDS OF GAUGE PRESSURE?** At that pressure the temperature would be 337° F.

114. **WHAT HARM WOULD IT DO TO CARRY MORE WATER IN A BOILER?** Carrying more water would not leave sufficient steam room in the boiler, and the boiler would be more liable to prime and foam. Water would be carried over with the steam into the engine. An engine runs best on dry steam.

115. **IS THE PISTON OF AN ENGINE IN THE CENTER OF THE CYLINDER WHEN THE CRANK PIN STANDS AT THE TOP OR BOTTOM QUARTER?** When the crank is at top or bottom quarter, the piston will be a little more than half way towards the crank end of the cylinder. Depends on the length of the crank and the connecting rod.

116. **WHAT ARE SOME GOOD RULES TO FOLLOW WHEN FIRING A BOILER?** Break up all lumps of coal, do not fire any lumps larger than your fist. When under load, keep the fire bright. If it becomes dark it is evidence the fire is getting "dirty" and needs cleaning. Keep coal forward to the dead-plates, fire lightly and often; do not allow the fire to burn down too low before throwing more coal. Do not allow holes to form in the fire, keep the fire even and level. Watch the draft and regulate it when conditions change. Close fire door after every shovel full so not too much cold air will be drawn-into the fire box area. Cold air will cause leakage at the tube ends and riveted joints. Maintain a steady water level in the gauge glass.

117. **WHY IS IT IMPORTANT TO HEAT BOILER FEED WATER?** It is a known fact that for each 11° F. increase in feed water temperature a saving of 1% in fuel will result. In other words it is cheaper and easier to fire the boiler.
118. **HOW IS FEED WATER HEATED ON A STEAM TRACTION ENGINE?** The feed water heater and heat from the steam when using the injector.
119. **WHAT IS THE DIRECTION OF THE CIRCULATION OF WATER IN THE BOILER?** Down the outer side of the boiler barrel and then up as the water gains temperature.
120. **WHAT ARE THE FOUR PRINCIPAL KINDS OF STEAM ENGINE VALVES?** The slide valve, the piston valve, the rotary or semi-rotary and poppet valve.
121. **IS IT DIFFICULT TO SET A VALVE?** No, it is easy. To set a valve when the motion is direct, place the engine on dead center, set the eccentric 90 degrees ahead of the crank, then with the valve in its central position advance the eccentric to give the desired lead.
122. **WHAT ARE THE TWO KINDS OF DRAFT TO REGULATE THE FIRE IN A STEAM TRACTION ENGINE BOILER?** “Natural draft”, which is airflow that is admitted through the open ash pit doors of the boiler and airflow due to heat expansion (the longer the stack the more the natural draft). “Induced draft” is when the draft is created or increased by the use of blowers or fans in greater volume than can be secured by the use of natural draft from the stack.
123. **IF THE SAFETY OR POP-OFF VALVE ON A BOILER IS SET TO DISCHARGE AT 100 PSI, AND THE STEAM PRESSURE WENT TO 120 PSI AND THE SAFETY VALVE DID NOT OPEN, WHAT SHOULD BE DONE?** Try opening the valve with the release lever. If the valve is stuck, supply feed water to cool the boiler water down. If under a load, close the drafts. Don't throw any fuel and let the steam be used by the engine. There is always the possibility of needing to smother the fire.
124. **WHY IS COLD WATER NOT EXPLOSIVE?** Because cold water, as a liquid, is non-compressible.
125. **HOW ARE TUBES OR FLUES FASTENED INTO THE FRONT AND BACK SHEETS?** By expanding and beading. They are sometimes welded after expanding.
126. **HOW IS WATER FORCED INTO A BOILER WHILE THE BOILER IS UNDER STEAM PRESSURE?** By pumps like a duplex or cross-head and injectors.
127. **NAME FIVE SAFETY DEVICES ON A BOILER LIKE THOSE USED ON A STEAM TRACTION ENGINE.** Steam gauge, safety or pop-off valve, gauge or sight glass, fusible plugs and trycocks.
128. **WHAT IS A HYDRO-TEST ON A BOILER?** Completely fill the boiler with water then add pressure to the amount that is approved for the particular boiler.
129. **WHAT WOULD BE REQUIRED TO MEET THE REQUIREMENTS FOR BOILER APPLIANCES, CONNECTIONS AND APPURTENANCES?** The Code requires, as a minimum on high pressure boilers, a pressure gauge and test connections, a safety valve, a blowdown valve, gauge glass, gauge cocks, a stop valve in the steam line, and stop and check valves in the feed line. In addition to the above, boiler feed pumps and/or injectors.

130. WHAT TYPE SAFETY VALVE MUST BE USED ON A STEAM TRACTION ENGINE BOILER? It must be the direct spring loaded type. The Boiler Code does not allow the installation of weight and lever type or dead weight safety valves.

131. WHAT IS THE MAXIMUM ADJUSTMENT ALLOWED ON A SPRING TYPE SAFETY VALVE? The maximum range of adjustment permitted with a spring is 10% of its rated setting. This rule is for safety valves set at up to 250 psi.

132. WHY IS A LIFTING OR TEST LEVER USED ON A SAFETY VALVE? It is required in order to lift the valve from its seat when there is 75% of the popping pressure in the boiler. Lifting levers that can lock the valve open are not approved.

133. WHAT IS THE PURPOSE OF THE WATER COLUMN? The water column is installed between the gauge glass and the boiler. It serves to eliminate excessive fluctuations of water-level indication in the glass due to rapid boiler circulation or ebullition and thus acts as a steadying media.

134. WHAT PRECAUTIONS SHOULD BE TAKEN WITH THE ENGINE BEFORE GOING UP A LONG HILL? See that there is the right amount of water in the boiler, that is, enough to show about two inches in the glass when the boiler is level. With the boiler too full there may be danger of the engine priming, which should be especially avoided on a hill. Have fire enough to maintain steam pressure; not enough to blow off when pulling hard as this can likely cause priming, necessitating stopping. Avoid stopping if at all possible, avoid running fast, a moderate speed will give best results. If the engine shows a tendency to prime, the speed should be limited by means of the throttle so that the engine may run just fast enough to pass its dead-centers.

135. WHAT PRECAUTIONS SHOULD BE TAKEN WITH THE ENGINE BEFORE GOING DOWN A LONG HILL? It is very important when going down hill to reach level ground before stopping. Every man should know who is in charge of an engine with the locomotive type boiler, the danger of stopping with front end low. In going down a very steep hill leave the throttle partly open to admit a little steam and if the engine runs too fast, control the speed with the reverse lever.

136. WHAT COULD BE THE TROUBLE IF THE GOVERNOR JUMPS OR IS IRREGULAR? Need for lubrication, greasy, crooked or loose belt, gland nut packing too tight, bent or worn stem, play between the collar on standard and lower arm holding sleeve.

137. WHAT IS "DRIFTING"? It is when a vacuum occurs in the cylinder as for example, when the engine is going down hill or "drifting".

138. HOW IS A GOOD WAY FOR A BEGINNER TO LOCATE A KNOCK OR POUND IN AN ENGINE? A good plan and one that will often show where the trouble lies is to have a man take hold of the flywheel and turn it an inch or so back and forth. By watching the crank box, cross head, main bearings and the reverse, any lost motion can be seen or felt.

139. IS AN ENGINE, FOR EXAMPLE A CASE, RUNNING "OVER" OR "UNDER" WHEN THRESHING? It is running "under". It would be "over" in road motion or traveling forward.

140. HOW DO YOU GET A SINGLE CYLINDER ENGINE RUNNING IN THE DIRECTION YOU WANT? Have the crank pin past dead center in the direction you want the crank plate to turn. If the crank pin is not in the right position to start, take the throttle lever in one hand and the reverse lever in the other. Admit a



little steam into the cylinder, reverse, and then before the engine can pass that center throw the reverse lever back, and the engine will start.

141. WHAT TROUBLE WOULD A LEAKY SMOKE BOX CAUSE? Any opening or holes in the smoke box will let outside air in and would have a tendency to destroy the draft.

142. NORMALLY HOW WOULD YOU FIGURE THE AMOUNT OF COAL AN ENGINE WOULD BURN? From 4 to 5 pounds of coal will be required per brake horsepower per hour. In other words an engine handling a 50 hp (brake) load would use 225 lbs. per hour.

143. WHAT IS MEANT BY EVAPORATING? The amount of water in proportion to the coal required is called the evaporation. Mostly it will be from 6 to 7 pounds of water per pound of coal on the smaller sized engines and may run as high as 8 or 9 on the larger engines.

144. IS STEAM CYLINDER OIL GOOD TO USE FOR LUBRICATING OTHER MOVING PARTS ON THE ENGINE? Many operators use cylinder oil instead of machine oil for lubricating the various parts of the engine. You will need only about half as much and it is less trouble to carry only one type of oil. It will cost a little more. However, cylinder oil is refined to enhance solubility and does not adhere as well to gears and journals.

145. WHAT DETERMINES THE AMOUNT OF STEAM CYLINDER OIL THAT AN ENGINES USES? The amount to use to secure good lubrication depends on the dryness of the steam. Wet steam will require more oil to get good cylinder to piston and valve lubrication.

146. WHAT DO YOU DO WHEN THE WATER DOES NOT SHOW IN THE GLASS? If the engine has been standing for a time, bank the fire and let the boiler cool down. If the engine has been working when low water is discovered, smother the fire with dirt or sand as soon as possible. Do not rake the fire because this will intensify the fire and increase the heat, which is the opposite of what needs to be done.

147. WHY NOT RUN FEED WATER FROM THE INJECTOR THROUGH A HEATER? The water delivered by an injector is so hot that it would absorb but little additional heat going through a feed water heater.

148. HOW WOULD YOU CLEAN LIME OUT OF AN INJECTOR? By soaking in a solution composed on one part of muriatic acid and ten parts of water.

149. WHAT IS THE DIFFERENCE BETWEEN AN INJECTOR AND AN EJECTOR? An injector will move water and produce a force on it to enter the boiler under pressure. An ejector is used for lifting water, filling tanks, they will not force water against the pressure of the steam that is operating them.

150. HOW DO YOU KEEP HEATER WATER FROM BLOWING OUT OF THE STACK? Drain the steam space of the heater before starting the engine.

151. WHAT IS THE PURPOSE OF A PEEP HOLE IN A BOILER FIRE BOX? To allow the operator to observe the flame in the fire box without opening the firebox door.

152. ABOUT HOW MUCH WATER CAN YOU FIGURE ON AN ENGINE USING WHEN WORKING? It is sufficiently accurate for calculating purposes to assume that 4 gallons (33.2 lbs) is required for each brake horsepower developed per hour. Thus a 30 horse engine would take 120 gallons per hour.

153. WHAT IS THE BEST WAY TO CHECK THE RISE OF STEAM PRESSURE? Start the injector. If the boiler is too full of water then close the draft doors.
154. IS THERE ANY ADVANTAGE TO DAMPENING COAL FOR USE IN THE ENGINE? Hard coal may be dampened to good advantage as it is less liable to “crowd” and will burn more freely.
155. WHY CLEAN FLUES AND HOW? Flues or tubes should be cleaned frequently as determined by the kind and amount of fuel used. The soot and build up should be removed with a brush or scraper type of cleaner. This removes the liability of the tubes becoming charged or heavily coated with a corroding acid and the soot or build up is a nonconductor of heat.
156. DOES A LOT OF THICK BLACK SMOKE COMING FROM THE STACK INDICATE A GOOD FIRE? Smoke will not be seen if combustion is perfect. Good firing will abate most of the smoke.
157. CAN YOU TELL ABOUT HOW HOT A FIRE IS BY LOOKING AT IT? Visual inspection can be pretty close. Cherry red is about 1600° F. Dull orange close to 2000° F. White heat is about 2400° F.
158. HOW MAY A BUILD UP OF SOOT ON THE BOILER HEATING SURFACES BE REMOVED? By brushing, by scraping and by blowing. It should be removed before it becomes caked. If it is loose and flocculent, it may be blown with either air or steam.
159. WHAT ARE THE TWO TYPES OF FUSIBLE PLUGS? Those that are inserted from the fire side of the boiler and those inserted from the water side. According to A.S.M.E. Code, the plug shall be filled with tin alloy which is designed for a melting point between 400° and 500° F. In the average size boiler, the size of the hole the fusible material is in shall be no smaller than 0.500".
160. WHAT ARE SOME LIKELY CAUSES FOR A BOILER NOT STEAMING? May be a defect in the boiler, dirty or obstructed flues, obstructed steam lines or exhaust lines, wrong size nozzle in exhaust or it could be poor fuel. Air leaks around the smoke box door and rings are frequent causes and some times are hard to find.
161. WHEN AND WHY WOULD YOU USE THE BLOW-OFF VALVE OR BLOW DOWN COCK? Reason for using blow-off cocks is to get rid of foul water. May be fouled by sediments or from some foreign material in the water that would cause foaming.
162. IS IT EVER ADVISABLE TO TRADE WATER FOR STEAM OR VISA VERSA? Most modern traction engine boilers steam freely, and it is not necessary to trade water for steam as was often necessary to lower the water level to get more steam for an extremely heavy load. It takes an alert engine operator to do this and not get into trouble.
163. HOW HOT IS THE WATER UNDER STEAM PRESSURE OF 140 POUNDS PER SQUARE INCH? Close to 352° F. And this would mean the amount of energy in foot pounds contained in one pound of water if set free to expand to the atmosphere would be 9992 ft-lbs. That is the reason a boiler explosion releases such terrific energy.
164. WHAT CAUSES SCALE IN A BOILER OR AN INJECTOR? The worst substances in the water are the carbonates and sulfates of lime and magnesium. These form a rock hard scale, especially if there is mud or

some other substance present. When water is heated to 280° the sulfates are no longer soluble and they fall. Carbonates drop out at close to 212°.

165. WHERE DO YOU FIND THE A.S.M.E. CLOVERLEAF STAMP ON A TRACTION ENGINE BOILER? Traction, portable and stationary boilers of the locomotive type have the stamp on the fire-box end and above the hand hole, or on traction boilers of the locomotive type, on the left wrapper sheet forward of the driving wheel.

166. HOW MUCH PRESSURE IS USED ON A HYDROSTATIC TEST? After a recurring boiler inspection has been completed it shall be subjected to a hydrostatic test of 1 to 1.25 times the maximum allowable pressure, to be determined by the inspector.

167. IS IT NECESSARY THAT A BOILER HAVE A PRESSURE GAUGE AND HOW IS IT HOOKED UP? The Boiler Code says each boiler shall have a steam gauge connected to the steam space or to the water column. The gauge shall have a siphon between it and the boiler.

168. HOW SHALL A DIAL ON THE STEAM GAUGE BE MARKED? The dial of the steam gauge shall be graduated to approximately double the pressure at which the safety valve is set. In no case to less than 1½ times this pressure.

169. WHY SHOULD A BOILER HAVE A REGULAR INSPECTION? To see that requirements have been met and complied with. The rules have been formulated to afford reasonably certain protection of life and property and to provide a margin for deterioration in service so as to give a reasonably long, safe period of usefulness.

170. WHAT IS A GOOD SURE AND QUICK WAY TO KEEP A CHECK ON THE ACCURACY OF THE STEAM GAUGE? When a safety valve pops, note the reading of the gauge, and if the reading is not in agreement with the stipulated popping pressure, better check the gauge when the engine cools down.

171. WHAT IS MEANT BY A TESTED STEAM GAUGE? A steam gauge is considered tested when it has been compared and made to agree with a testing device or a test gauge which recently has been so tested.

172. IF STEAM SHOULD ACCIDENTLY BE ALLOWED TO ENTER THE STEAM GAUGE, WHAT SHOULD BE DONE WITH IT? If steam has entered the gauge it must be re-tested.

173. WHAT SHOULD BE CAREFULLY OBSERVED AFTER A STEAM GAUGE HAS BEEN TESTED? Never place any strain on a gauge case after testing, such as may be done by holding case when connecting piping to gauge. If a wrench fitting is not part of the gauge install one before testing the gauge.

174. SHOULD YOU CLEAN A SIGHT GAUGE GLASS? No! When they need cleaning replace with a new clean one.

175. HOW OFTEN SHOULD YOU BLOW DOWN A SIGHT GLASS? Whenever it gets fouled. Especially after trouble is experienced with boiler compounds, foaming, priming or other feed water troubles.

176. IS IT ALL RIGHT TO USE THE SAFETY VALVE TO LET STEAM PRESSURE DOWN WHEN THERE IS LOW WATER? No! Safety valves shall not be opened to reduce steam pressure in the case of low water.