

WASHING TURBINES TO REMOVE CARRY-OVER DEPOSITS

While considerable advance has been made in improving the evaporation process, the carry-over problem is not yet completely solved, and it is necessary to have practical methods available whereby deposits may be removed from the blading of a steam turbine once they have been found. It is usually possible to prevent the formation of non-soluble carry-over by proper feed water treatment, so that the problem concerns chiefly the removal of material soluble in water.

There are two fundamentally different methods available for doing this. The safest from the point of view of the turbine is to shut the machine down, let it cool thoroughly, and then slush the blade path with hot water. This is rarely possible, however, since it requires a shutdown of several days. The other method, which is more common, is to desuperheat the steam before the throttle valve in gradual steps until it is practically saturated and will become wet as it passes through the turbine. Operation is continued under these conditions for a few hours, at the end of which time the deposit will usually have disappeared. Normal operation is then re-established by gradually restoring the normal operating steam temperature at the throttle.

It is evident that this method represents a severe strain on the turbine, even when conducted in the most careful manner. If carried out improperly, it may cause serious damage by distortion of the stationary parts. It is recognized, however, that in spite of these risks, washing may be necessary, and a suggested procedure is given below. The best method of carrying on the various steps can, no doubt, be determined by actual study and experience with each unit under the particular Plant conditions existing. All such washings and their consequences must be considered as a part of the plant operation and maintenance, and as such, are the responsibility of the owner.

Washing may be done at half load or less, but in any case with a all governor valves open except in the case of straight reaction type turbines, in which case only the primary governor valve is to be opened. The lower the washing load the smaller the quantity of de-superheating water and in general the longer the washing period. Method A, below, is applicable whatever the washing load, while method B is applicable without using a header steam valve.

Whatever the method used, it can be made safer if the throttle steam pressure and/or temperature is lowered prior to washing. This can usually be done in the case of unit boiler-turbine systems. The temperature drop should be gradual and not to exceed 60°F. per hour.

METHOD A

Washing at Loads Up to 50% Rating

- (a) A connection from the boiler feed line should be made to the main steam line at least fifty feet ahead of the turbine throttle valve. The connection should lead into the pipe through a nozzle, or nozzles, to break up the water into a spray as it is admitted into the pipe. The spray should be directed against the direction of steam flow in the line. The number and size of the holes in the spray nozzle should be regulated so that, with the steam flow specified below and with full boiler feed pressure at the inlet of the nozzle, sufficient water can pass to bring the steam temperature at the inlet to the turbine to a point ten degrees above saturation, (corres-

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ponding to the pressure existing at the point at which the temperature is read.)

- (b) A steam pressure gauge and a quick response thermometer (preferably of the continuous recording type) are to be located in the steam supply line adjacent to the throttle valve. These must be high grade and accurate instruments as they provide the criterion of proper desuperheating.
- (c) Set the turbine rotor in the "start and stop" position, if it is equipped with an adjustable thrust bearing, the adjusting mechanism of which is used in normal operation.
- (d) If the turbine has a ventilating steam supply line, close it.
- (e) Gradually close the header valve partway to lower the throttle steam supply pressure as the speed changer is advanced to fully open the steam inlet valves. The throttle steam pressure should be reduced until the desired washing load is carried with full open steam inlet valves. This adjustment should be made over a period of time varying between 15 minutes for a 10,000 Kw turbine to 45 minutes for 75,000 Kw turbines and larger.
- (f) Open all drains wide in the steam inlet pipe, throttle valve, turbine cylinder, extraction zones, dummy leakoff spaces, etc.
- (g) With the inlet valves fully open, the governor thereby inactive but capable of closing in an emergency, and steam header pressure sensibly constant, it should now be possible to control steam temperature accurately by water injection.
- (h) The operator should listen for rums or unusual noises during the washing process, particularly when water is being admitted. Any increase in the amount of vibration should be noted. Arrangements should be made so that the water may be shut off immediately and the machine taken out of service should any rums or other unusual conditions develop.
- (i) Admit water through the spray nozzles, gradually increasing the amount until the pressure and temperature at the throttle show 10°F. superheat. Temperature should not be reduced below this value or all indication of water content may be lost. The rate of decrease of temperature must be uniform in small increments and must not exceed 60°F. per hour. As a further criterion the cylinder thrust pedestal movements should be recorded. At intervals of an hour while desuperheating allow temperatures to stabilize to the point that the pedestal movement substantially stops, indicating that the cylinder temperatures are following the steam temperature changes closely.
- (j) When 10°F superheat is reached, operate for about two hours at this condition. Sampling the discharge from open cylinder drains will generally show the effect of washing and indicate when the process is complete.
- (k) After washing is complete, gradually shut off desuperheating water. The rate of steam temperature increase should be the same as specified for desuperheating.
- (l) Reverse the process of Paragraph (e) to restore normal throttle steam pressure, taking the same time period.
- (m) Close drain lines ten minutes after completion of washing.

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- (m) If operating procedure calls for change of the turbine rotor axial position in normal rise, it should be restored to "running" position only after normal steam temperatures have been obtained.
- (o) If there is a ventilating steam line, open the ventilating valve.
- (p) Increase the load gradually and check the pressure distribution. The real test for the cleanliness of the blades is the pressure distribution. Readings should be taken before the washing operation, so that a full knowledge of the change effected will be available.

METHOD B

Washing Without Using Header Steam Valve

If the header valve cannot be used to lower inlet pressure to the throttle valve, washing must be done at the load corresponding to the steam flow passed by the throttle pilot (or inner) valve only. It is necessary to establish a reference point to show when the throttle valve pilot valve is fully open but the main valve closed. This can be done as follows: Just after a shutdown with the throttle thoroughly heated, close it and scribe a line on the valve stem to indicate the closed position. Then scribe another line to indicate the position of the stem when the pilot valve just starts to open the main valve. This lift can be obtained from the throttle valve assembly drawing.

These scribed lines will serve to show the operator the amount of valve opening for washing.

Since cold position may differ considerably, reference lines should be obtained with the valve hot.

Washing then may be done exactly as in Method A except for the following:

In accordance with paragraph (b) the steam pressure gauge and quick response thermometer (preferably, the continuous recording type) are to be located preferably between the steam inlet valve group and turbine. In the case of turbines with the steam chest integral with the turbine casing, these instruments may be located between the throttle valve and the steam chest.

In paragraph (c) reduce the turbine load to zero keeping the unit on the line.

Close the throttle valve slowly until the reference mark on the stem shows the pilot valve is about 1/8" below the point where the main valve begins to open.

Move the speed changer in the "increase load direction" until all steam chest valves are wide open. The unit will then carry the load corresponding to the steam flow through the throttle pilot valve.

SUGGESTED DESUPERHEATING NOZZLE ARRANGEMENT

Figure 1 shows a suggested method for the admission of water to the main steam line. The small fittings may easily be welded to the outside of the steam line, thereby requiring only small holes for the water admission. The dimensions shown refer only to a specific case; namely, a 10,000 Kw., 1200 lb. turbine, for which the steam supply was 229,000 lb. per hour. The feedwater pressure was 300 lb. in excess of the main line steam pressure. The initial steam temperature was 725 degrees F. Under

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these conditions, it was necessary to admit 33,500 lb. of water per hour at a temperature of 212 deg. F., to bring the temperature of the mixture to within ten degrees of saturation. Note that three $9/32$ " nozzles were required for this particular case. For other conditions, the appropriate number and size of nozzles must be employed.

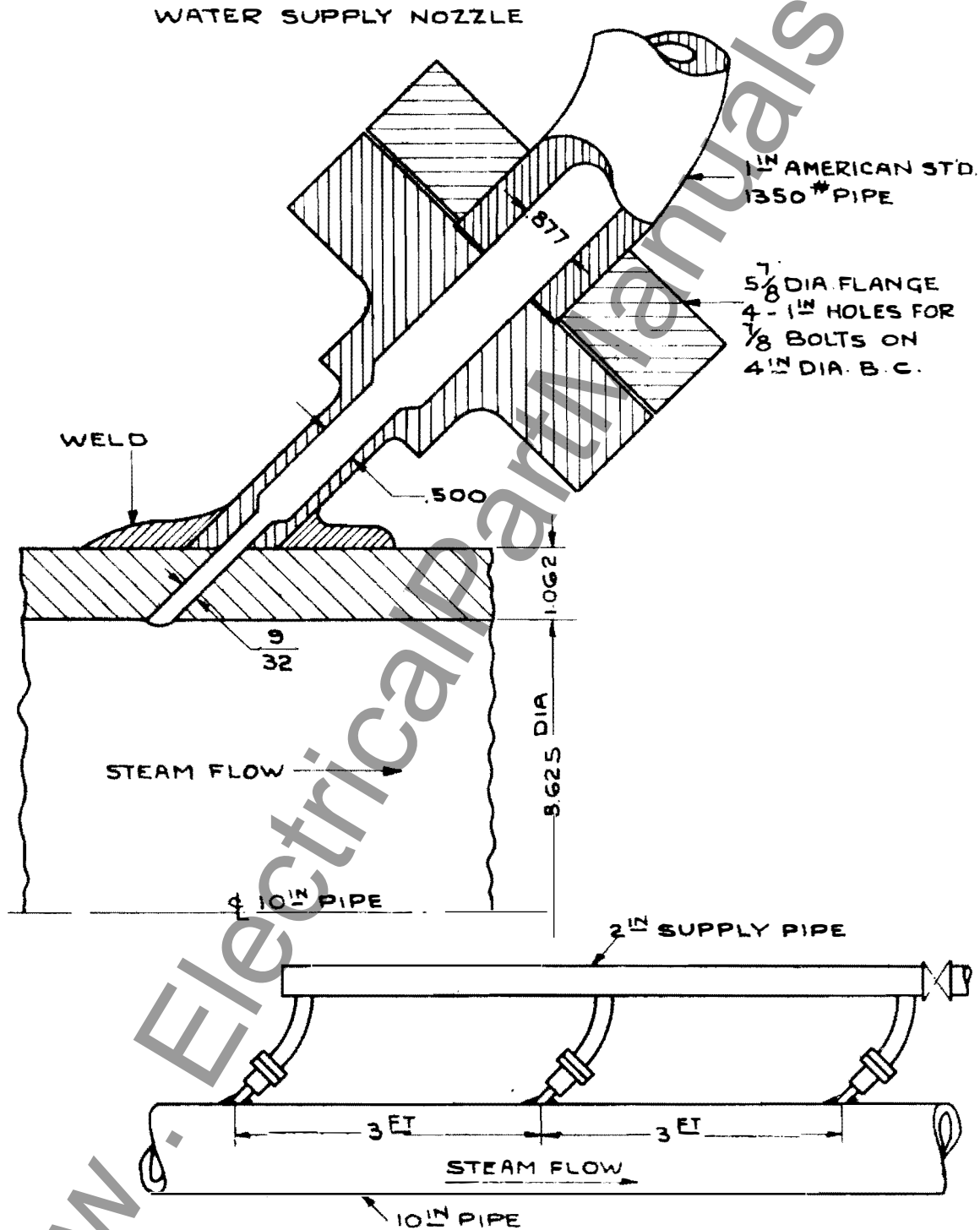
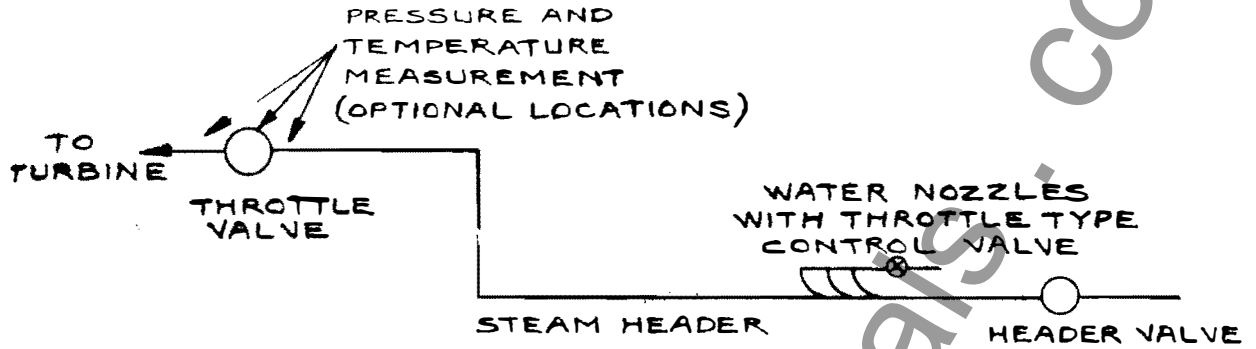


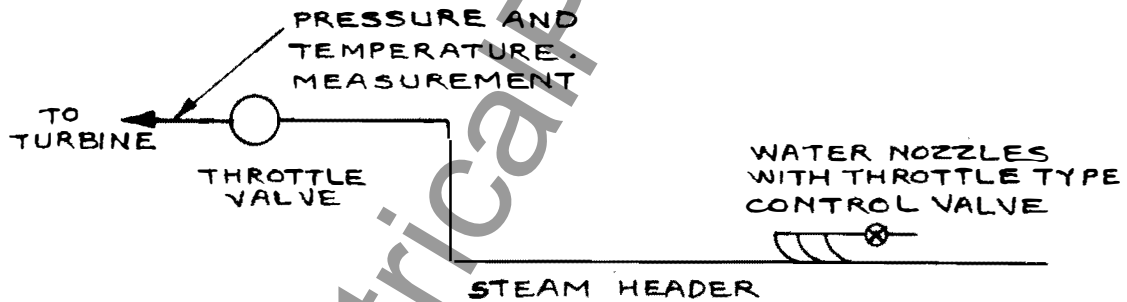
Figure 1

Washing Turbines to Remove Carry-Over Deposits



WATER NOZZLES TO BE AT LEAST 50 FT. AHEAD OF THROTTLE VALVE

METHOD A



WATER NOZZLES TO BE AT LEAST 50 FT. AHEAD OF THROTTLE VALVE

METHOD B

Figure 2