ANALYZING WATER SUPPLIES

INTRODUCTION

Adequate public and/or private protection is a basic specification for a well protected risk. Key components include water based extinguishing systems, such as sprinklers, waterspray systems, hose connections and hydrants, all of which require adequate water supplies.

Determining the adequacy of a water supply requires that the supply be tested, demands analyzed, and the supply compared to the demand. The need for both an initial and a second supply must also be evaluated. Following the analysis, the supply is rated and recommendations are made for any necessary improvements.

SCOPE

This material should be used in conjunction with PRC.14.1.1.0 and PRC.14.1.1.1. Where a second supply is provided, this method should be used to evaluate both the initial and second supplies. When either the initial or second supply is comprised of more than one source (pump, public water system, etc.), the combined flow from each source may be used for the evaluation of that supply. The procedures in this guide to analyze and rate initial and second supplies are applicable for all types of facilities.

AXA XL Risk Consulting guiding principles for the protection of oil and chemical properties, outlined in PRC.17.2.1, PRC.17.3.1 and PRC.17.3.4, require that the fire water supplies be adequate to supply the water demand for a period of four hours while considering the largest single impairment to the fire protection system. Rating a water supply with the largest single impairment equates to evaluating a second water supply. Impairments that should be considered are outlined in PRC.14.0.1. The reliability of fire pump drivers in high-hazard chemical and petrochemical plants should be closely reviewed; generally diesel engine driven fire pumps are preferred. In refineries and oil terminals, at least half of the fire pumps should be driven by diesel engines.

Guidance for gas and oil compressor or pumping stations, as found in PRC.17.3.2 and PRC.17.3.3, takes precedence where there are differences.

METHOD

Analyzing the adequacy of a water supply is a multiple step process. The steps are as follows: (See Figure 1.)

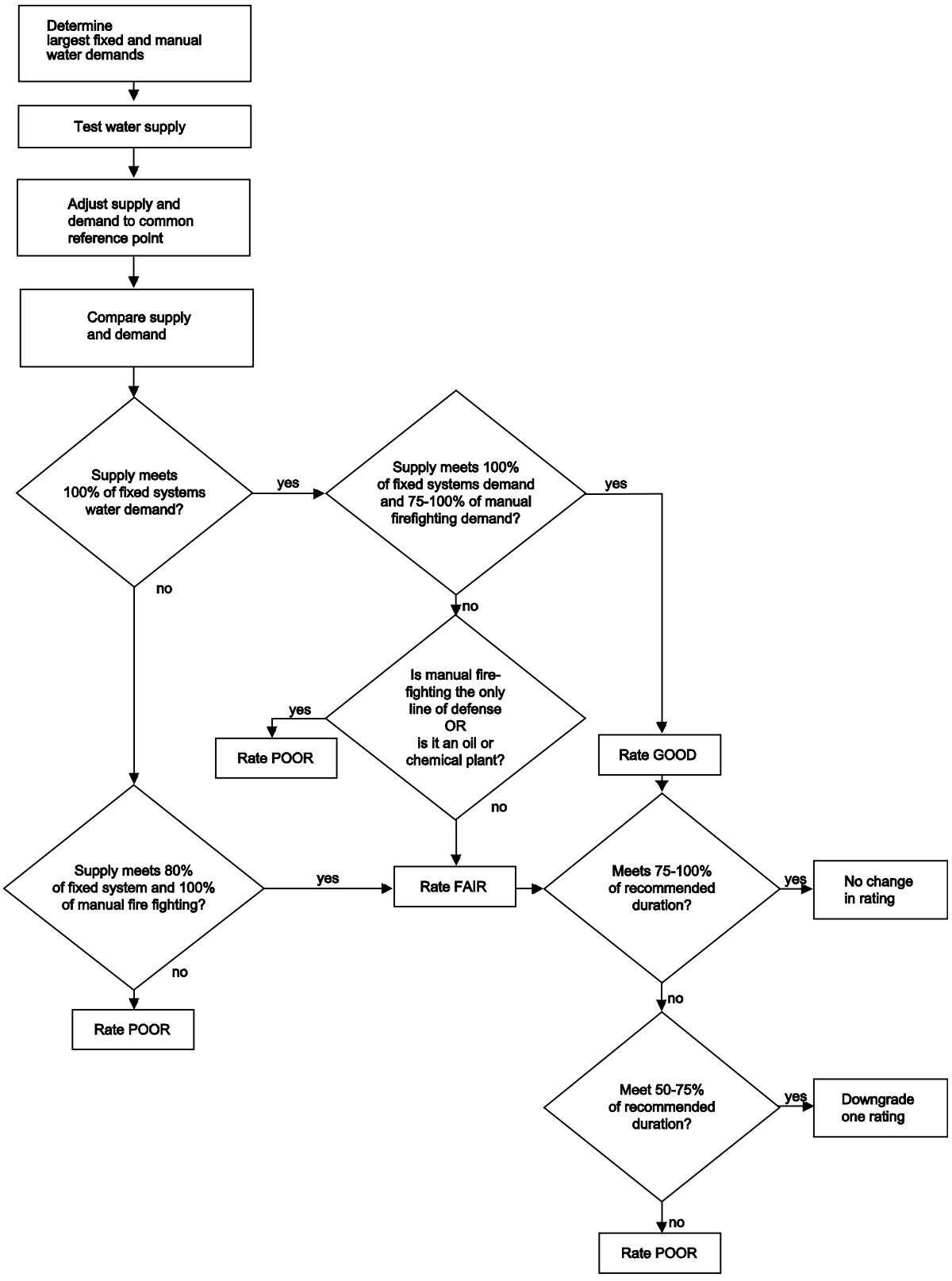

Figure 1. Water Supply Rating Decision Tree.

- **Determine the demand**.

The water supply demand and duration should be obtained using PRC.14.1.1.0 and PRC.14.1.1.1. Judgment must be exercised to insure that the largest anticipated demand is determined. Usually the largest demand will determine the adequacy of the water supply. Areas with smaller demands may need to be evaluated due to elevation, remote location with respect to the supply, or small underground piping. The intent is for the water supply to adequately supply all areas of a facility.

- **Obtain recent water supply test results**.

Accurate water supply tests are necessary if the analysis is to be valid. The test should identify any fluctuations that may be encountered due to the time of day, seasonal demands, drought, or a deteriorating water supply. In general, the water test should be no more than two years old, and tests older than five years should not be used.

The location of the test is important. Ideally, the flow test should be as close to the demand location as possible. General “area tests” should not be used to evaluate a water supply unless there are no private testing facilities and a local test cannot be arranged. A single hydrant should not be used for both flow and pressure measurements unless no other choice is available. The exact test location should be documented, along with any elevation differences between the test and demand locations.

When the water supply being analyzed consists of more than one source, a combined flow test with all sources on-line is preferred. Individual tests may be combined by calculating each source back to the point where they come together, the sources combined, and the combined supply calculated back to the connection of the sprinkler system to the underground.

Pumping supplies should be designed so that the demand will not exceed 120% of the rated capacity of the pump. When evaluating existing pumping supplies, judgement must be used when the demand requires the pump to be used at flows beyond this point. Whenever demands require a pump to exceed 150% of its rated capacity, additional pumping supplies should be recommended with pump sizing based on all pumps operating at a maximum of 120% of capacity. In no case should a pump operating in excess of 150% of rated design be accepted.

AXA XL Risk Consulting recommends that fire pumps be driven by diesel engines in high-hazard chemical and petrochemical plants and where the electric power supply is questionable.

AXA XL Risk Consulting recommends that at least 50% of the pumping supplies be diesel driven in refineries and large gasoline plants.

For oil and chemical properties, the second water supply or supply with the largest single impairment should be compared against the water demand.

- **Adjust the water test results to obtain the flow and pressure available at the demand location (normally the base of riser)**.

Before the water supply test results can be compared with the water demand, a common reference point is required. The test results must be adjusted from the test location to the point of demand (typically the base of riser). When making a comparison of fixed system (e.g. sprinkler) and water supply demands, the common reference point should be the connection of the sprinkler lead-in to the underground.

This analysis assumes that the sprinkler demand at the connection of the sprinkler lead-in to the underground is the same as the base of the riser demand. This assumption is reasonable unless the length of the lead-in exceeds 50 ft (15 m), there is an elevation difference, or significant friction loss is expected, e.g., when the lead-in is 4 in. (100 mm). For most systems, the loss in the lead-in will be less than 5 psi (0.35 bar). The hose demand should then be added to the sprinkler demand and compared with the supply.

When adjusting the supply to the common demand point, the calculations should take into account the size, age and construction of the mains, elevation differences, fittings, etc. Any assumptions used in making the evaluation should be documented.

- **Compare the water supply available (flow and pressure) with the demand and rate the supply**.

Once the protection demands and the supply available are known at a common reference point, then a comparison can be made to evaluate the adequacy of the supply. Each source should be evaluated to determine its acceptability. If a single source is not adequate, then two (or more) combined sources are to be analyzed.

This analysis is done in several steps.

- The water supply is compared with the demand to determine what combination of fixed systems and manual fire fighting demands can be supplied at the flow and pressure available.
- The duration desired is compared with that available.
- The supply is given an overall rating based on the flow, pressure and duration provided by the supply.

First, the ability of the water supply to meet the fixed system demand is evaluated to determine a preliminary rating. The water supply, corrected to the common reference point, and the fixed system demand points should be plotted. The manual fire fighting demand is then added to the fixed system demand by adding the required flow to the fixed system flow at the fixed system demand pressure and the total demand point plotted on the graph.

The “preliminary” rating is based on the flow and pressure requirements and is determined as follows:

Good- The supply is capable of delivering both the fixed system and 75% – 100% of the manual fire fighting (hose) demands.

Fair- The supply is capable of delivering only the fixed system demand, and manual fire fighting is not an essential line of defense.

The supply is capable of delivering the manual fire fighting and 80% of the fixed system demands. This situation may occur where there is a strong public water supply at moderate pressures (40 psi – 60 psi or 2.8 bar – 4.1 bar).

Poor- The supply cannot deliver the manual fire fighting and 80% of the fixed system demands.

The supply can meet the fixed system demand but cannot meet the manual fire fighting demand where it is an essential line of defense.

Next, the water supply duration is compared with that desired, and the final rating is determined:

- If the preliminary rating is good or fair, the duration of the supply is evaluated, and the preliminary rating adjusted.
- If the preliminary rating is poor, no further evaluation is necessary.

When adjusting the rating, the demand that can be supplied in the preliminary rating is used. For example, if the supply can only supply sprinkler systems but not manual fire fighting demands, the duration would be evaluated based on the sprinkler demand only.

The adjustment is made as follows:

- **No change** - The supply can meet the demand for 75% – 100% of the recommended duration.
- **Downgrade one rating** - The supply can meet the demand for 50% – 75% of the recommended duration.
- **Rate poor** - The demand cannot be supplied for a minimum of 50% of the recommended duration.

SUPPLY RATING

A “good” supply may not be “adequate” from an underwriting standpoint. A secondary supply is usually needed for large, high valued risks (See PRC.14.0.1).

The water supply grading of Excellent, Good, Fair, Poor or None - (E, G, F, P, N) on the Risk Summary of the Loss Prevention Survey is determined from this analysis. Except for oil and chemical properties, it does not take into account the need for a second supply. The grading is limited to G, F, P or N when no second supply is provided.

For oil and chemical properties, a second supply is required, and the rating based on the second water supply (largest single impairment).

For all other properties, an “excellent” rating is reserved for cases where more than one supply is provided. When a second supply is provided and both the initial and second supplies are rated “good,” the grading should be increased to “excellent” as shown in Table 1.

TABLE 1
Water Supply Rating

Initial Supply	Second	Risk Summary
Good	Good	Excellent
Good	Fair	Good
Good	Poor or None	Good
Fair	Fair	Fair
Fair	Poor or None	Fair
Poor	Poor or None	Poor
None	None	None

IMPROVING FAIR AND POOR SUPPLIES

As stated earlier, the water supply should be adequate to meet the largest water demand. When the analysis indicates that this cannot be done, either the water supply must be improved, or the demand modified so the existing supply can provide adequate water.

Occasionally, it is obvious where the deficiency lies and what improvements to recommend. More often, however, several options are available, any of which would improve the sprinkler/water supply system and result in adequate protection.

One common situation resulting in an inadequate water supply rating occurs when the sprinkler system was designed for a different hazard than now exists. This can happen when the occupancy changes (such as from manufacturing to warehousing) or when the materials stored change. Recently, this has been a more common occurrence as many products are now manufactured out of plastic rather than metal, increasing the hazard of the commodity. The demand required (pressure and flow at the base of riser) to provide an adequate density from an existing sprinkler system in these cases will often be unrealistically high.

Another case occurs when the water supply it is not strong enough to allow the design of a sprinkler system to the required density. This is typical of supplies where the static pressure is low, or the pressure drops off rapidly as the flow increases. Finally, there are many cases where it is not obvious where the problem lies. Either a sprinkler system reinforcement or a water supply improvement will result in an adequate rating in these cases.

Sprinkler systems should be designed so full advantage can be taken of the water supply. Excessive base of riser pressures restrict the use of any supply. AXA XL Risk Consulting recommends that sprinkler system base of riser design pressures do not exceed 125 psi (8.7 bar). It is desirable that any fire pumps be able to operate at 120% – 150% of their rated demand and still be able to meet the required sprinkler demand.

On the other hand, the water pressure must be high enough so the private fire brigade or public fire department can effectively use fire hose. Ideally, fire protection systems should be designed to 75 psi – 100 psi (5.2 bar – 6.9 bar) and the water supply designed to supply the required flow at this pressure.

When evaluating possible improvements, there are three cases to examine. Where the water supply cannot provide the desired flow at a pressure of 75 psi (5.2 bar), recommendations for water supply improvements should be made. Usually additional pumping supplies will be required, but occasionally the problem will be due to improperly sized underground and in this case larger underground piping may solve the problem.

If the water supply is inadequate, but can provide the required reinforced sprinkler flow at a pressure of 75 psi – 125 psi (5.2 bar – 8.7 bar), the sprinkler system should be hydraulically modified. An exception to this rule involves tall buildings or structures where higher pressures are required to reach the top of the building.

The final case is where the available pressure at the required flow is between 75 psi – 125 psi (5.2 bar – 8.7 bar) and the sprinkler demand is below 125 psi (8.7 bar). In this case, the inadequacy can be corrected by either a water supply improvement or a sprinkler system reinforcement. The route chosen will depend on the number of systems that need to be reinforced, the nature of the needed water supply improvements, expansion plans, and the costs/benefit of the various alternatives.

In oil and chemical occupancies, the reliability of the pumping supplies can be increased by replacing electric motor or steam turbine fire pump drivers by diesel engines.

SUMMARY

The evaluation of water based extinguishing systems and their water supplies cannot be separated. When the water supply rating is inadequate, often the system can be improved by either reinforcing the sprinkler system or improving the water supply. The action required will depend on flow and pressure available from the existing supply, the sprinkler system demand pressure, the nature of the hazard, and the characteristics of the underground distribution system. Recommendations for improving an inadequate supply can only be made after considering these factors.