The question is vital as to whether this seepage has endangered the tank enough to affect its stability. We do not believe it has. On the lower 2 ft. of the tank, and in one spot higher up, there has been some frost action, so that in places pieces of the concrete have spalled off. In two places around the base of the tank there are small areas where the spalling has reached a depth of 3 ins. I think that on its ninth birthday it will need a little repairing.

An attempt was made the summer before last to do some repairing on the inside by applying a waterproof film. The work was done by a local contractor, and no engineer was consulted in connection with it. As I understand it, it cost something like six or seven hundred dollars. A brush coat of hot tar was painted upon the interior wall. This attempt at waterproofing does not appear to have reduced the seepage at all.

Mr. Raymond C. Allen, civil engineer, Manchester, Mass., reported his observations on the Manchester standpipe as follows:—

The standpipe at Manchester was built very carefully, and of the best materials. Shortly after it was filled a fracture appeared at the first joint at the base, which in a short time extended a length of about 30 ft. Through this fracture the water in a short time came in a sheet, over a length of from 10 to 12 ft., and trickled through at other points. One other leak of quite considerable proportions appeared about 15 or 16 ft. up. This was not as wide as the other, but similar. There was no other leak, but there was a seepage at many of the joints.

We tried first a cement coating. We found it unsuccessful. Then the two joints which were in the worst condition were repaired by putting a layer of lead with tar over them, as Mr. Andrews has described. This sealed these joints until a year or two ago, when the pressure forced the water into that crack to the extent of fracture, and the leaks again appeared.

Those two leaks were repaired about a year ago by an asphalt and felt waterproofing process, and the standpipe has been protected within by some further construction against ice and other damage.

I have noticed that the greatest amount of seepage and of leaks has occurred on the south and west sides, where the expansion seems to be most unequal. I have also noticed that as from time to time the standpipe is lowered entirely and filled again, the successive fillings have produced new points of seepage. At all events, they act a little differently, and are cumulative in their effect. Thus each time a standpipe is emptied and filled, I believe that a slight increase in seepage for a time at least takes place.

We at first feared the action of frost—although our fears were somewhat allayed at the time by others who had built concrete standpipes. Last year we had a piece about 8 ft. square thrown off at about the location of the upper leak to which I have referred. This was clearly the action of frost, and the action of it upon the concrete was completely to disintegrate it. It was just so much sand. That was true upon some portions of the base upon which the water had been constantly running and freezing, but behind the reinforcement, where no movement of concrete had taken place, there was no disintegration. It was only in the outer shell where disintegration took place or any damage appeared in the concrete.

I have come to the conclusion, myself, that such standpipes as are over about 50 ft. in height should be entirely waterproofed on the inside by some preparation. I will go a little further and say that I feel that the outside of the tank itself should be protected from the elements. For, while the greatest danger from frost comes from the freezing of seepage through the structure, I believe that in time at least the action of snow and rain and the water coming down from the roof will have the same effect as it will when a larger amount of water comes through from the inside in the form of seepage.

Mr. Francis W. Dean, of Boston, gave the following information relative to the standpipe at Lexington, Mass.:—

If I remember rightly, an effort was made to prevent leakage in the first place by pasting canvas on the inside, using marine glue. It was supposed not to dissolve, but some months later it was found that most of the canvas was at the bottom of the standpipe.

Furthermore, the leakage was confined to quite a small area, and chiefly on one side, about 25 ft. from the bottom, as I remember it. Afterwards, when cold weather came, a small part of it spalled off, and that has been repaired. I believe the leakage now is almost nothing.

Mr. William S. Johnson, civil engineer, Boston, Mass., gave his views on concrete standpipe as follows:—

My experience has been limited to rather low tanks, and unless I change my opinion very materially, my future experience will have the same limitations. None of the tanks which I have built is over 40 ft. in height, but they all leak more or less. There has been no spalling off of the outside surface, and the actual quantity of water passing through the concrete is very small, but it is enough to make the tanks unsightly, and, of course, arouses a certain suspicion as to the safety of the structure in the minds of those who know little about these matters.

I am convinced that high standpipes are much better built of steel than of concrete. To be sure, the steel tanks are unsightly, but so are concrete structures, discolored by leakage. The repairs on a steel tank are expensive and annoying, but they cannot be more so than the repairs to concrete tanks. As to the durability, the evidence indicates that concrete tanks are far from indestructible, and there is much uncertainty as to how long they will really last.

Until some better method of designing and constructing concrete tanks is found, it seems to me very unwise to install them to hold more than 50 ft. of water.

Lisbon, Me.—Mr. Stephen Litchfield, city engineer of Bath, Me., gave the following information relative to the Lisbon standpipe:—

The standpipe for the town of Lisbon was completed in October, 1909, and put into commission in January, 1910. The diameter is 50 ft.; the height, 62 ft. (internal dimensions); capacity, 190,600 gals.; thickness of shell at base, 20 ins.; at top, 12 ins.

The structure is designed on the basis of the steel reinforcement, taking all tensile stresses at a working unit stress of 12,000 lbs. per square inch in the steel with the standpipe full.

The structure rests on a hard-pan bottom. Floor slab is 20 ins. in thickness, of 1:2:4 concrete reinforced with 3 ins. No. 10 standard expanded metal. Over the concrete base or floor is a 1-in. granolithic surface 1:1 mortar with 2 per cent. of Medusa Compound added to the mix.

The walls are composed of 2:1.5:3 concrete. Bank gravel, screened and washed, was used in the mixture. In the top of the floor and in walls 5 per cent. of hydrated