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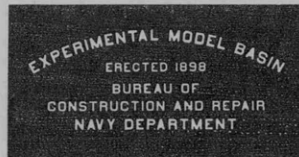


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UNITED STATES
EXPERIMENTAL MODEL BASIN

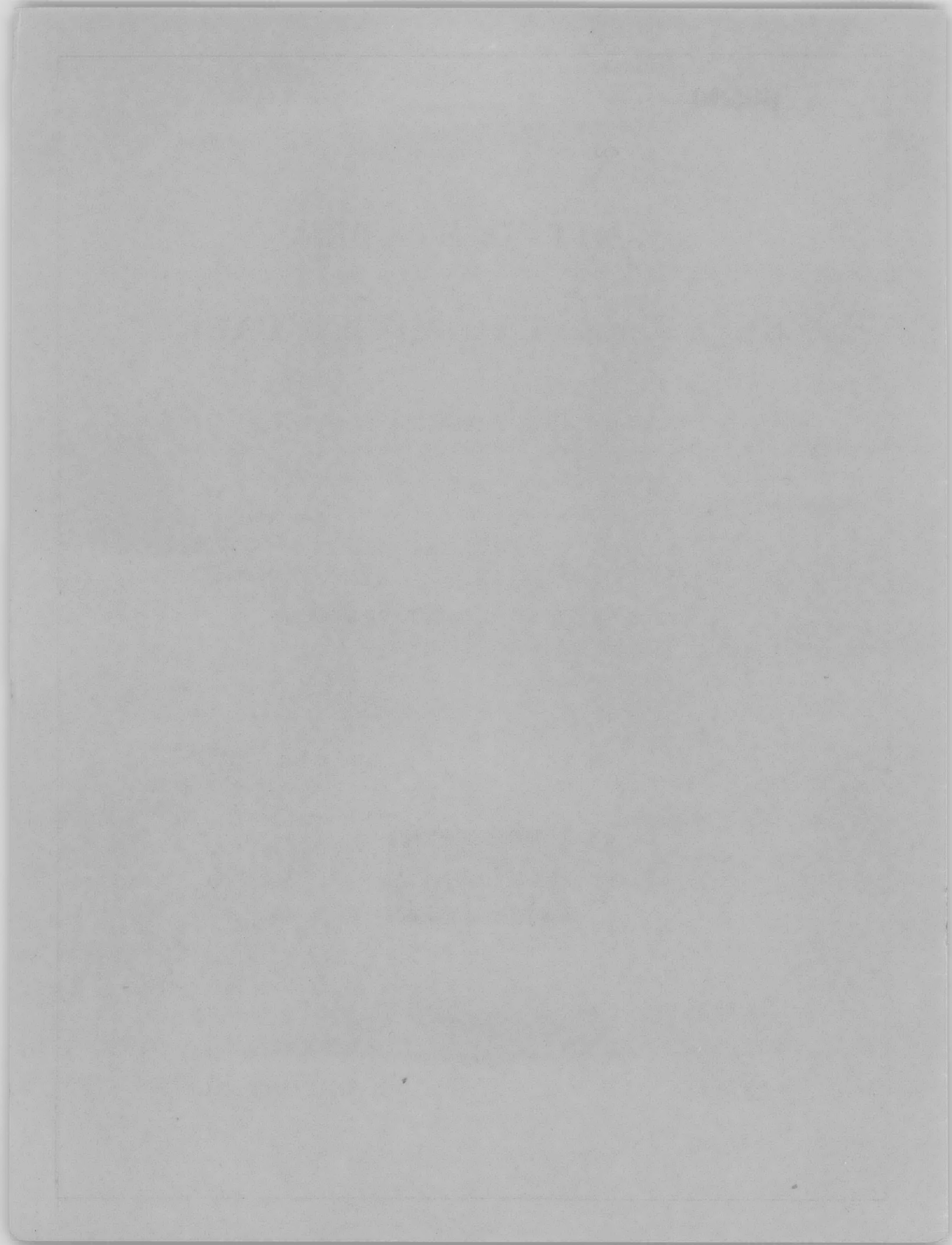
NAVY YARD, WASHINGTON, D.C.

WOOD MODELS vs. PARAFFIN MODELS



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REPORT NO 319



WOOD MODELS vs. PARAFFIN MODELS

The question of material for model hulls has been often raised. Practically every other Model Basin uses paraffin whereas the Washington Basin uses wood. The commonest explanation is that the summer temperatures in Washington prevent the use of paraffin during that season, since paraffin will soften and change shape at about 75° F., whereas the water temperatures in the Basin in summer run as high as 80° F. and the air temperatures may be at times around 100°F. However, this objection to paraffin, although quite valid, would apply also to certain other basins, notably the one in Rome and probably the one in Vienna. It is probable that in these places in hot summer weather not much of this work is done, but the Washington Basin at the present time cannot afford to stop work because the weather is hot; the work load is too high.

There are many other reasons for preferring wood to paraffin which may be briefly expressed as below. There are also some supposed disadvantages, chiefly that of relative cost. The latter, however, after the lapse of time and sufficient acquaintance with the methods to be used, have proved to be, if not entirely unfounded, at least of small importance. The actual cost of making a model in paraffin in those basins which use it is not known; but since the processes of making models in wood or paraffin are entirely analogous in every step, the only possible increase in cost for wood would be the cost of material, inasmuch as the paraffin in the models that are discarded can be used over.

This, however, at present applies to a certain extent to the wooden models. It cannot apply entirely because storage facilities are not sufficient, and unless models that would be suitable are to be broken up at the time when new models are to be made the material available in old models could not be used. With the present flow of work it is, however, often possible to use parts of old models in the manufacture of new, and in any case parts of old models are drawn upon as material for other lines of work.

To judge from the charges made for making and towing a model in the Washington Basin and the others, it would appear that the cost of making a paraffin model is much greater than the cost of making a wooden model. Thus to make a 20-foot wooden model, bare hull, and to tow it under one condition at this Basin costs about \$450; to do the same work at the Teddington Basin in England, which uses paraffin models somewhat shorter than 20 feet, the standard charge is about \$700. The cost of the material in the case of the wooden model, if mater-

ial is all new, is in the neighborhood of \$100. Therefore, this is the only item of the cost which could make an appreciable increase. Wooden models can be carried along in numbers from time to time as convenient and the work can be properly managed. Paraffin models must be completed and gotten into the water for storage without delay, otherwise they will change shape. This, in itself, is a great advantage of wood and tends to make the cost less than it would otherwise be.

Paraffin models will change their shape if not kept submerged and must be stored submerged in water until wanted. This requires a difficult storage space which is not necessary for wood. Also paraffin models for this very reason cannot be kept a long time. If they were, the material charges to be saved by the use of the same paraffin in successive models would, of course, disappear. The advantages of storing models without difficulty are, of course, obvious. The storage arrangements at this Basin accommodate at present about 150 models, depending on the size; the storage space has, from time to time, been encroached upon by other activities. Some models have been stored here for 20 years or more. It is common practice to keep models representing actual important naval vessels indefinitely and there are tests made on them from time to time as questions involving resistance or propulsion come up. Such work in the case of paraffin could be done only by making new models.

If proper care is taken paraffin models can be stored for several months without change in shape that would cause difficulties, but much more care is necessary than in the case of wood. A wooden model made of good white pine with casein glued joints, such as used at present, will last without distortion indefinitely. The handling to which these models are subjected is very rough; practically every model that is stored is damaged in a minor degree by handling, and requires minor repairs and repainting before it can be used again. Such handling would probably destroy a paraffin model, assuming that such a model could be stored in a similar manner.

It has been said that wooden models are more difficult and expensive to manufacture on account of the character of the material. This might have been the case in the earlier days but with the developments that have subsequently taken place, it is probable that there is no difference in the labor costs at the present time in favor of paraffin; it is much more likely to be the reverse. The expensive and complicated machines that were first installed for manufacturing wooden models have now been discarded and the process is simple and direct. Only

one machine for making wooden hull models is used and this is a combination machine used for other purposes as well.

Paraffin models have not the strength that can be obtained in the case of wood and will not stand the same amount of handling nor the same character of testing. It has been found difficult abroad to make paraffin models regularly as long as 20 feet. Most of the routine models are much shorter. A few models have been made of the size that is standard at this Basin, but these are commonly reinforced by iron or wood, and if not so strengthened have been known to give trouble. One model at a foreign tank, it is understood, which was run in very recent times, broke up during the running. On the other hand at the Washington Basin models have frequently been made in lengths greater than 20 feet. Lengths of 30 feet are not infrequent. One model has been made as long as 60 feet, and another, or a combination of models, was made up to a length of 110 feet. The only limit to the length or other dimensions of wooden models is the size of the basin and the limits thereby imposed on the speed and the length of run of the model. Such large work is entirely impossible in paraffin. A series of models is underway, composed of 6 bows, 2 sterns, and 12 parallel middle bodies, making 156 separate combinations. This would be impossible in paraffin.

At the present date a very large percentage of all models is fitted out complete with appendages, including bilge keels, docking keels, struts, shafting, propellers, rudders, and in some cases even minor appendages. One model was fitted complete with plating laps to scale. This last item would have been entirely impossible in paraffin. The others are difficult and paraffin models commonly are not fitted with them. Anyone who has watched the facility with which appendages are fitted to a wooden hull or with which appendages are removed and others substituted would realize that such work is difficult, if not impossible, in paraffin. Even the making of alterations in the main hull, which is supposed to be a principal advantage of paraffin, can be equally well done in the case of wood. To cut a wood surface below the original surface presents no difficulties whatever, as long as sufficient thickness of material is available. To patch material on the outside or inside, as necessary, is easy and frequently done. It is, in fact, no more difficult to patch on a new piece of material with glue than it is to pour on new material in paraffin.

Steering tests with the model free and turning under its own power in the basin are becoming more frequent and more important. Such work is practically impossible in paraffin. A 20 foot wooden model weighing 2000 lbs., driven by its

own propellers at full model speed of, say, 3 or 4 knots, is turned under its own rudder, and brought up all standing after about a 90° turn, with its bow striking against the side of the Basin, (the shock being taken on an hydraulic buffer fitted to the bow). This can be and is done with wooden models; it could not be done with paraffin models.

Probably the most important difference due to the use of wood or paraffin for a hull model is in the uniformity of the results of the tests. It has been long supposed that the smooth slick surface of a paraffin model, which cannot readily be duplicated in wood, gives the paraffin model an advantage. It is true a completed wooden model made at Washington is not as smooth as a paraffin model. Acting on the above supposition, attempts have been made from time to time to improve the quality of the surface of the wooden model. The first models were made of white pine and were finished with a special varnish. After a certain period redwood was substituted for the white pine because it was cheaper. Its use has, however, since been discontinued because it does not work as readily, is unpleasant to handle inasmuch as it splinters readily and the splinter wounds always fester, and lately it has not been readily obtainable or cheap; and therefore white pine is again used. The special varnish coating has been omitted because it has been found by experience to be unnecessary and for the last few years ordinary oil paints have been used for a finish.

The wood model will change shape slightly. The wood will show its grain and some roughness where end wood is exposed and the painted surface can never be made as smooth as paraffin unless extra work in rubbing down is put on it. Long experience has, however, shown that the slightly rough surface given by the above apparent defects is very desirable to get consistent results. Paraffin models very frequently, especially when of small dimensions and at low speeds, give trouble because the smoothness of the surface encourages the persistence of laminar flow. At low speeds it is often possible on successive runs at the same speed to get very different resistances, sometimes even in the ratio of 2 to 1. Our wooden models that are somewhat rough, especially at the bow, are very largely out of the region of laminar flow and results can be duplicated, even at low speeds, much more readily. The prevailing opinion in shipbuilding circles of the superior accuracy of results at the Washington Model Basin as compared with others is very largely founded on this apparent defect in the surface of the model. It is true that this roughness must not be exaggerated and attempts must always be continued to obtain uniform standard surfaces. At the same time if the

general surface is fairly smooth, resistances as shown by many tests do not vary appreciably.

At the present time the Basin has gone back again to a special varnish for a finish. This is still in its experimental stage. The purpose is not, however, to obtain a smoother finish but to get a finish in less time and with less cost. With the proposed routine a model is ready for painting in the evening and is then given a priming coat of oil paint. On the next morning this coat is dry and the model is puttied to fill defects in the surface. It is then immediately given a coat of shellac which is almost immediately covered with a coat of special enamel; this dries in about 6 hours; is much harder and more resistant to wear than oil paint; and makes it possible, if necessary, to put the model in the water for testing the same evening. Commonly, however, this is not done until the next morning. The time taken in painting is, therefore, very little over 24 hours, whereas previously, with the number of coats of oil paint applied, several days were required.

A minor difficulty in the case of wooden models is that of keeping the model tight. Glued joints will in some cases open and leak, but with the present technique this is a very rare occurrence and is usually readily repaired with a little putty. Paraffin models are, by no means, entirely free from similar difficulties. If the temperature of the water in which they are stored is very different from the basin temperature, they are likely to crack when placed in the basin for test.

Judging from the precautions taken when running paraffin models abroad, such as carefully brushing the bottom when submerged to remove air bubbles, the submerging of the model for about 3 days in water before it is ready to run, and a final rub down given to the surface at the end of this period, it would seem that there are many such time-killing difficulties from which wooden models are free.

After the experience of 30 years during which this Basin has been in operation, after long study of the methods of making and fitting up models in wood, of the convenience of making changes, installing apparatus, and testing under novel conditions, the conclusion is justified that paraffin cannot compare with wood under modern conditions and that any basin, no matter what the summer temperature, should not use paraffin for models if a large output and high grade of work are desired. In some new basins the attempt is made to provide for the use of both paraffin and wood. It can be readily said that any force of good

workmen can be trained to make either paraffin or wood models, but not both; that if both methods are to be used, the force of trained men must be doubled; and the outfit of special machinery must likewise be doubled, since machines that are suitable for paraffin are not suitable for wood. In this connection it should be pointed out that machines for cutting paraffin models have always been made to cut along water lines, whereas machines made at this Yard to cut wooden models make the cut along the transverse section. The difference is clearly conditioned by the character of the material and the method by which the final hand work is carried out.

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