GOVERNMENT NOTIFICATION.—No. 132.

The following Report on the proposed erection of a Refuse Destructor for the City of Victoria, Hongkong, which was laid before the Legislative Council this day, is published.

By Command,

J. H. STEWART LOCKHART,
Colonial Secretary.

Colonial Secretary's Office, Hongkong 27th February, 1899.

INTRODUCTION.

Principles to be observed.

The conditions which should govern any enquiry into the best means of disposing of the garbage and refuse of cities and towns are stated below in their relative order of importance.

A. The health of the city being the first consideration, the most efficient (*i.e.*, sanitary) method of disposal should be adopted irrespective of cost.

B. Such method should cause no danger or inconvenience to the neighbourhood to which the refuse is removed.

C. Consistent with efficiency, such method should be as economical as possible—

(i) In initial outlay.

(ii) In annual recurrent expenditure.

D. Consistent with efficient destruction, the best means should be followed of utilizing any valuable products the refuse may contain, in order to minimize, as far as possible, the cost of disposal.

Collection of Refuse.

This report in no way attempts to deal with the method of collecting the refuse, nor with the cost of such collection, but it is assumed that the cost will be practically the same, whether the refuse be taken, as at present, to dust boats stationed at various places along the Praya wall, or whether it be taken in the dust carts to a Refuse Destructor which may be erected on the outskirts of the City.

Past and Present Procedure.

Until within recent years, a most common method adopted by cities and towns for disposing of their refuse was that of dumping it upon a piece of waste ground selected as near to the town as possible. Towns on the seaboard sometimes adopted an alternative plan of barging the refuse to a place at sea, where it could be dumped without risk of being washed back on to the foreshore.

The first method was followed in Hongkong for many years, the refuse being dumped at Belcher's Bay on a foreshore which has since been reclaimed, and is now a part of the City of Victoria, viz., Kennedy Town. This dumping ground having become unsuitable, another place was found on the Chinese mainland, where dumping was allowed under certain conditions. It appears that these conditions have been infringed and hence the present enquiry and report.

Dumping the refuse on the mainland embraces the disadvantages of both the above methods, and, although preferable to dumping close to the City, is still unsatisfactory.

METHODS OF DISPOSAL.

Dumping Grounds.

"From a report made by Professor BURDON SANDERSON, M.D., and the late Professor PARKES, M.D., on the 'Sanitary Condition of Liverpool' (I quote from Knight's "Annoted Model Bye-Laws") experiments having for their object to ascertain what the effect of time had been on the organic matters which, together with cinder refuse, had been used to fill up inequalities in the ground tended to shew that 'the process of decay of all the most easily destructible matters,' including vegetable refuse, 'is completed in three years.'" If this be so it follows that a dumping ground will constitute a danger to health for three years after the last load has been dumped.

The dumping ground for Hongkong is on the mainland and well removed from the Island, but there is such close communication between the Colony and the mainland, that any disease breaking out on the latter would be quickly conveyed to the Colony. Any action therefore of the Colony, which may produce a breeding ground for disease, cannot fail to affect it detrimentally.

It is difficult to say at what time the refuse becomes really dangerous to health, but it would be wise to provide means which would ensure that all refuse be removed from the City within twenty-four hours of collection, and that it be not afterwards disturbed until it has been rendered harmless.

Removal within twenty-four hours is, I believe, effected at the present time, but the system is liable to disarrangement from wind, storms and tide.

It would also be wise to minimize the handling of the refuse, which is at all times an unhealthy occupation, and which becomes more so the longer the refuse is stored. At present the refuse is handled three times.

1. In collecting from the house and placing in the dust carts.
2. In removing from the dust carts to the dust boats.
3. In carrying from the dust boats to the dumping ground.

The third handling must continue under the present method of disposal, but might be obviated either by dumping at sea from hopper barges or by burning near the City.

The following objections then are urged against the present method of barging the refuse to the mainland and carrying it to a dumping ground there :—

1. The refuse itself forms a breeding ground for disease.
2. Delays in removal of several days may be entailed by high winds, typhoons and storms.
3. The refuse has to be handled more frequently than by other methods.

Dumping at Sea.

The second method of disposal is that of dumping at sea. To do this would necessitate the use of specially-constructed hopper barges, which would practically take the place of the present dust boats. A sufficient number of barges and tugs would be required, working under European supervision, as to ensure the removal of each day's refuse within twenty-four hours of collection. The barges containing the refuse would require towing out to sea each day, where the refuse would be emptied, at such a distance as would render impossible any return to the harbour or foreshore.

This method, if properly carried out, is open to fewer objections than that of dumping on land, for no breeding ground for disease is formed and the third handling may be obviated by dropping the refuse into the sea through the bottom of the barge.

There still remains, however, the objection of delays which will occur with every blow or storm, when the refuse for four or five days, or even more, may have to be kept in the City or in boats and barges along the sea front.

Burning.

The most efficient means of disposal is undoubtedly that of destruction by fire, and I believe it possible, by the erection of suitable furnaces to burn the whole of the City refuse within twenty-four hours of collection, and this without risk of delay by wind and storm and with only two handlings. Kurrachi in India, where a similar class of refuse would obtain, is burning it successfully, while Penang, Singapore and Madras are erecting Destructor Furnaces.

So thoroughly have the evils of dumping refuse on land, and the advantages of burning it at a high temperature become recognized, that at least eighty cities and towns or vestries in Great Britain have already erected furnaces, while many more in Britain, in the Colonies and on the Continent are either erecting Destructors or are making enquiries in view of doing so.

DETAILS OF FURNACES AND WORKING.

Introduction.

Having generally described and compared the three "Methods of Disposal" applicable to Hongkong I will now deal specially with the proposal to erect Destructor Furnaces and describe such furnaces in detail. Before proceeding, however, I should state that having visited several cities and districts where Destructors are working and seen different patterns, I drew up a specification, which I attach, of the general requirements for Hongkong and asked four of the best known firms to submit designs and estimates. This course was adopted because practically every part of the furnace is patented, while opportunity is given to the different patentees to adapt their several types and patents to the local requirements. Two of the four firms only responded to my request, and the designs, estimates, etc., are attached to this Report.

General.

The principal points to be attended to in designing a furnace are :—

1. That the arrangements shall be such, and the heat sufficient, to thoroughly burn the material and gases and render both innocuous.
2. That such arrangements shall be made as will effectually prevent the escape of dust or unconsumed fumes from the Chimney.
3. That, consistent with proper burning, the arrangement of furnaces, flues and boilers shall be such as to obtain the best calorific results.

The Furnace.

In all types of furnace I have seen, the refuse is burnt in the front, while fresh refuse is fed on to a hearth at the back, where it is partially dried before being raked on to the fire and burnt.

In one type of furnace the outlet flue is at the back and close to the feed opening, so that the heated gases from the fire pass over the unconsumed refuse, thus helping to dry it, but at the same time carrying off unconsumed and noxious fumes to the flue.

In the other type of furnace, the outlet flue is in the front and over the hottest part of the fire, and the unburnt refuse being, as in the first type at the back, the fumes of this drying refuse are brought over the hottest part of the fire and are thoroughly heated, before reaching the flue.

This latter arrangement appears to me to be the more scientific of the two, for whereas, in the first case the heated gases from the burning refuse are cooled in passing over the unconsumed refuse and thus enter the flue with a reduced temperature, in the second case the fumes from the unconsumed refuse pass over the hottest part of the fire and eventually pass out of the furnace thoroughly heated and innocuous.

Draught.

There is a diversity of opinion as to the relative advantages or otherwise of natural and of forced draught, but so far as I can ascertain the latter is considered the better by those who have had most experience.

The advantages of forced draught are that a higher temperature can be maintained, the rate of burning is accelerated, and the necessity for a very high chimney is obviated; on the other hand, there is a greater risk of dust, etc., escaping from the chimney and becoming a nuisance.

On behalf of natural draught it is urged that a sufficient heat is obtained to properly burn the refuse, with less wear and tear to the furnaces and a consequent lower annual outlay in repairs.

Under forced draught, fewer furnaces do the work so that there are less to repair; refuse can be burnt more quickly, and from personal inspection of both, I find that a greater steam pressure can be maintained in the boilers.

The force of the draught is usually equivalent to a pressure of about $\frac{5}{8}$ inch of water, but in Messrs. BEAVAN and DEAS' furnaces a pressure of 2 inches is maintained, hence the high consumption at Leyton. (See below.)

Forced draught was specified for the proposed furnaces for Hongkong.

Flues.

The design and arrangement of the flues is an important factor in the subsequent successful working of the furnaces, for it is by them that the heated gases from the furnaces are conveyed and utilized, and in them that the dust is intercepted. They should be of such design as, for instance, to admit the fixing of boilers and the introduction of carcases to be cremated, though this is sometimes done in the furnace with small carcases of dogs, cats, &c. and with condemned meat.

The flues should also be so placed that the loss of heat by radiation is reduced to a minimum.

Fume Cremators and Dust Catchers.

In the old type of furnace with natural draught, it was generally found that unconsumed gases escaped from the chimney, creating a nuisance in the neighbourhood. To obviate this a second furnace, called a cremator, was constructed in the flues between the refuse furnace and the chimney, where the fumes passed over a special fire in order to render them innocuous. This arrangement is extravagant as it involves additional expenditure in fuel and attendance.

With a properly-designed furnace such additional expenditure should be unnecessary; it is, however, wise to introduce a cremator if it can be worked without additional expenditure, and this can generally be effected in connection with a "dust catcher."

A simple arrangement of the latter is shown in the design submitted by Messrs. GODDARD, MASSEY AND WARNER, and consists of a blank wall built across the flue, with a pit at the bottom, the flue being increased in height above the wall to give the required sectional area. The dust is intercepted by the wall and falls into the pit at the foot, while the draught is impeded and probably the temperature raised in consequence.

A very ingenious cremator and dust catcher has been recently erected at Edinburgh by the Horsfall Syndicate and a similar one is proposed by them for Hongkong. The flue ascends in a short spiral round the outside and to the top of a domed chamber; the gases enter this chamber through the dome and pass out to the chimney by a flue near the bottom. There is a depth of some three feet at the bottom of the domed chamber below the outlet flue which acts as a dust box. This cremator is said to throttle the heat and thus raise the temperature, and cremate the fumes. The draught beyond the cremator is dependant upon the height of the chimney, but can be regulated by dampers.

Chimney.

The usual height of chimney for furnaces with natural draught is about 180′, this great height being rendered necessary to produce a draught in the furnaces and to obviate as far as possible the escape of dust, paper, etc. from the top. Where forced draught is used, one reason for the great height is removed, for the chimney is relieved of all duty in producing draught in the furnace itself and receives assistance for the draught required in the flues, and it should be possible to so design the flues as to intercept all paper and dust.

A lower chimney has the double advantage of costing less in initial outlay and upkeep and of being less liable to damage by typhoons.

Efficiency of Furnaces.

The quantity of refuse, which may be burnt per diem by any type of furnace, can only be ascertained by experiment, as it depends so entirely upon the calorific qualities of the refuse dealt with and the period of burning.

For instance, at Leyton where Messrs. BEAMAN AND DEAS' furnaces have been erected, it is stated that under forced draught 16 tons per cell per diem are burnt, consisting of refuse and sludge mixed in the proportions of $1\frac{1}{2}$ to 1.

At Whitechapel, Messrs. MANLOVE ALLIOTT & Co.'s furnaces are said to burn 10 tons per cell per diem under natural draught.

At Edinburgh, where the refuse is said to be very poor in quality, 8 tons per cell per diem are burnt by the Horsfall furnaces under forced draught. The furnaces are, however, new and better results will probably be obtained.

At Bow Road, Poplar District, where Messrs. GODDARD, MASSEY AND WARNER'S furnaces are working, I learn that $6\frac{1}{2}$ tons per cell per diem are burnt under natural draught; it is expected that 8 tons or more will be burnt when forced draught is fitted. At Kurrachi, India, the same firm have erected a 2-cell Destructor which is reported to burn 11 tons per cell per diem under natural draught.

It will thus be seen that results vary considerably, and I am of opinion that in designing furnaces for Hongkong it would be unwise in the present state of our knowledge to calculate on burning more than 6 tons per cell per diem.

The refuse from a Chinese city, where all cooking is done on charcoal ranges or chatties, will almost certainly have a lower calorific value than that of a European city where the refuse contains some 60% of cinder, which assists in the burning and is the chief factor in producing heat. The Hongkong refuse, however, contains a quantity of vegetable matter, rattan shavings and other combustible matter, and no difficulty is anticipated in successfully burning it.

It is needless to say that one type of furnace may burn more than another, or that the quantity burnt may be regulated by the hardness of clinker required. The longer the period of burning and the higher the temperature, the harder will be the clinker. In England the period of burning varies from one to two hours per charge.

Disposal or Utilization of Clinker.

There will necessarily be always a certain quantity of waste material to dispose of after the burning. Quoting from a report by Sir A. BURNIE and Dr. SHIRLEY MURPHY to the London County Council, dated May 10th, 1893, by burning in a Destructor "the matter collected is generally reduced to about one-third its original weight and to about one-fourth its original bulk. The organic and combustible matters are burnt, and the residue consists of ash and clinker free from matters which can become offensive, and which are, if the Desturctor is properly used, purified from possible sources of contagion."

The residue has been utilized in various ways as follows, and it has in certain instances been sold.

At Manchester—the clinker, when ground up and mixed with lime, makes an excellent mortar which is easily disposed of, the demand being in excess of the supply.

At Hornsey—"the clinker is used for mortar, concrete, hard-core for new roads, paths, for making paving slabs, etc., and a ready sale for same is found at 2*s.* 0*d.* per one-horse load (at the Depôt) when the Council have any to dispose of."

At Edinburgh, the clinker is used for raising the level of low-lying ground within the curtilage of the works.

Being thoroughly burnt and therefore harmless, the clinker may safely be used for filling up hollows in waste ground, and could be disposed of in this way on the Reclamation Works so long as they are in progress, or at Kennedy Town where there are building sites several feet below the level of the roads and where I anticipate that the permission of the owners would be readily given.

It is possible that some of the residue may be sold, but as granite can be easily obtained for concrete and red earth for mortar, and both are probably better for the purpose, this possibility must not be reckoned on.

Should it become necessary to barge away the clinker—a contingency I do not anticipate—the matter collected will still have been reduced to about one-third of the original weight and the necessity will not exist for immediate removal.

Utilization of Heat.

Although the sole object of the furnaces is the destruction of the city refuse, it is yet possible that, after such destruction, use may be made of the heat generated. The various ways in which this heat may be utilized were set forth as follows in the specification submitted to the firms for tenders:—

(a) To cremate carcases of cattle.
(b) To cremate, or dry for manure, offal from the Slaughter Houses.
(c) To destroy mattresses and infected clothing.
(d) To supply heat for a 100-H. P. boiler.

The boiler to be used :—

(i) For heating water for use in the Slaughter Houses.
(ii) For a Disinfecting Plant.
(iii) For driving an engine of 50-H. P.

In drawing up this Specification I had Kennedy Town in view as the locality of the Destructor.

It may also be possible, after the erection of a suitable chamber, to use the heat for cremating human bodies ; the question of building a Crematorium has already been broached and with a nominal expenditure the experiment might be tried in connection with the Refuse Destructor.

Of the foregoing proposals *D* (iii) is the only one needing further remarks.

The Horse Power to be obtained from a boiler heated from a Refuse Destructor will depend upon the heat generated in the cells and upon the position of the boiler so as to best utilize this heat. The calorific properties of Hongkong refuse being an unknown quantity, it is impossible to estimate the size of boiler that should be provided or, indeed, to say whether a boiler should be fixed at all ; under these circumstances I recommend that no boiler be purchased in England in the first instance, one can be obtained locally for the purposes of experiment.

The 50-H. P. engine would also wait ; but if the necessary heat can be obtained to raise steam to drive it, it might be used to drive a dynamo for the following purposes, viz.:—

(a) To light the Slaughter House and Destructor Works and, if desired, the Infectious Diseases Hospital.

(b) To pump water to the Peak by means of an electric motor, fixed at the Bonham Road Pumping Station.

The above assumes that no monopoly has been granted to the Electric Light Company to supply electric power to Government buildings.

SITE.

The City extends for some four miles in length, and as all refuse has to be taken to the Destructor, the latter should be in as central a situation as possible and it should also be on the lower levels.

The value of ground in the central portion of the City on the lower levels is so great as to prohibit the erection of a Destructor there, and the alternative appears to be the erection of two Destructors, one at Kennedy Town in the west, the other in the vicinity of Causeway Bay in the east.

The alternative possesses the advantage of disposing of the refuse on the outskirts of the City where any risk of nuisance is reduced to a minimum, while by the erection of two Destructors the distance of conveyance after collection will be considerably reduced.

I have previously described the uses to which a Destructor could be put if erected at Kennedy Town, but I venture to suggest that a Disinfector, and a furnace for cremating cattle, would also be useful at the east end of the City, while, if the heat generated be sufficient, the Destructor works there might eventually be utilized for pumping, in connection with the completion of the sewerage scheme for the City when this is carried out, which scheme includes pumping the sewage of the Eastern District out to North Point.

The initial cost, as well as the working expenses for two Destructors, will be greater than for one of equal capacity, but I believe the sanitary advantages will be found to thoroughly justify the additional expenditure.

SCHEMES SUBMITTED.

Messrs. Goddard, Massey and Warner.

I propose to deal first with the scheme of Messrs. GODDARD, MASSEY AND WARNER.

This firm has had some experience in the East in the erection of a Destructor of two cells at Kurrachi, which is reported by the Municipal Engineer to burn eleven tons per cell per diem, and they consider that to calculate on a basis of nine tons per cell per day will allow a safe margin. Ten cells are therefore provided for the ninety tons.

The type of furnace proposed is that with the outlet flue at the back, behind the drying hearth and close to the feed opening. Provision is made to assist clinkering and to avoid the fire "caking," by the introduction of movable firebars which I have seen working successfully.

The scheme provides for the refuse to be tipped from the carts on to the floor over the cells, from whence it is raked into the charging hopper. This hopper is a simple contrivance for feeding the furnaces by means of which a measured quantity can be shot into them by pulling over a lever.

The fans would have been placed more advantageously if at the other end of the furnaces, for it is obviously a better arrangement that the stronger draught should be at the far end rather than in the middle of the flue ; it has possibly been so arranged, however, in consequence of the provision asking for additional cells. The arrangement for regulating the draught to each furnace is worthy of attention ; it will tend to counteract the disadvantage and assist in controlling the fires.

Placing the engines and fans, as shown between the furnaces and the boilers, will result in the temperature of the gases being unnecessarily reduced before reaching the latter and thus render them less effective. I have already pointed out the necessity of placing the boilers as close as possible to the furnaces.

A simple arrangement of "dust-catcher" has been designed and is described on page 335.

The usual height of chimney for *natural* draught furnaces has been provided, probably in consequence of the proximity of the Slaughter Houses.

The Horsfall Syndicate.

The scheme of the Horsfall Syndicate is very complete. The furnace is of the better type having the outlet flue in front and twelve cells have been provided on the basis that each will be capable of burning 7½ tons per diem.

Provision has been made for storing the refuse on the works in trucks, which can be run on rails and tipped, the refuse being thus discharged into the furnaces without additional handling.

The furnaces are divided into two sets and the forced draught, although not entirely free from the objections previously urged, is well arranged.

The boilers are placed as close to the furnaces as possible and are thus in the best position to utilize the available heat.

A "dust-catcher" or beehive cremator, as working successfully at Edinburgh, has been provided for while the chimney is but little more than half the height of that proposed in the other scheme.

Special provision has been made for drying blood (for manure) and arrangements have also been made for fixing an "economizer" to heat the feed water to the boilers.

Comparison.

For comparison I propose to describe the scheme of the Horsfall Syndicate as the "Horsfall" and that of Messrs. GODDARD, MASSEY AND WARNER as the "WARNER."

Comparing the two schemes it will be observed that, on the principles laid down on page 334, the Horsfall type of furnace is the better of the two. The Horsfall Syndicate *guarantee* to burn 7½ tons per cell per diem as against 9 tons *estimated* by Messrs. GODDARD, MASSEY AND WARNER; I have seen both kinds working and from observations and from enquiries I am confident that the former will burn as quickly and as well as the latter.

There is a considerable difference in the estimated cost per cell. For instance—

12 Horsfall cells and flues, ...£4,380.18.4 Forced draught, ... 270. 0.0	£4,650.18.4. = £387.11.6	cost per cell.
10 Warner cells and flues, ...£2,522. 0.0 Forced draught, ... 475.10.0	£2,997.10.0. = £299.15.0	,,

The size of the cells being practically the same, it seems probable that the difference in cost is to be accounted for mainly by a different price being adopted for workmanship and materials, and that the ultimate cost in Hongkong of either design would be much the same.

In the "Warner" design it is arranged to use the platform over the clinkering space as a tipping platform and this might equally well be done in the Horsfall scheme. The latter scheme, however, to conform with the specification, has provided a special tipping platform and storage bay with rails, and waggons sufficient to hold the refuse of one day, in order as requested to minimize the handling, and the cost of this must be deducted in comparing the two estimates.

The boilers should cost the same whichever scheme is adopted, but as I do not recommend obtaining boilers from England in the first instance, their cost may also be eliminated. I have already pointed out that they are better placed in the Horsfall scheme than in the Warner.

The Horsfall scheme proposes a chimney only 109 feet high, which, with forced draught and their patent dust-catcher, is claimed to be equally effective with a higher chimney and results in an estimated saving of £850 over that of the Warner scheme.

The buildings with platform are nearly the same size in both schemes, but are again priced higher in the Horsfall estimates, but as in the case of the furnaces it is probable that the ultimate cost in Hongkong would be much the same.

To sum up, both schemes have been carefully worked out, but I am of opinion that the "Horsfall" scheme is the better of the two in type of furnace, in general arrangement, and in detail.

RECOMMENDATIONS.

From the foregoing it will be seen that in my opinion—

(i) The present method of disposal constitutes a danger to the health of the Colony.

(ii) The alternative of barging to sea, although an improvement on the present method, still has the great objection of delays by tides, storms and typhoons.

(iii) Burning is the most sanitary method of disposal and therefore the right one to adopt.

With our present limited knowledge, it would be wise in the first instance to experiment by burning a portion of the city refuse, before deciding on a scheme for disposing of the whole. These experiments might last for one year, during which time the remaining portion of the refuse would continue to be barged to the mainland as at present.

For the purposes of these experiments, I recommend the erection of four Horsfall cells with flues, dust-catcher, chimney and the necessary buildings, at Kennedy Town, on a convenient site near the Slaughter Houses and Infectious Diseases Hospital. With this plant can be ascertained the quantity

of refuse which each cell will burn per diem and the heat that can be obtained for steam raising. If the cells are equal in efficiency to those at Kurrachi, then they will burn 11 (tons) × 4 (cells) = 44 tons of refuse per day or half the estimated total of the city. If they burn but 6 tons per cell per diem, but still work so successfully as to justify the erection of more, then the Destructor at Kennedy Town could be extended and a second erected near Causeway Bay at the same time. Even should it be subsequently decided not to burn, the first Destructor will still be available for the purposes mentioned in items *(a)*, *(b)* and *(c)*, on page 336.

In the first instance, the patent charging apparatus with waggons, tipping platform and storage bay might be omitted; they could be added subsequently if found desirable.

There will probably be a boiler belonging to the Government available for fixing temporarily to ascertain the steam pressure obtainable and to drive the engine and fans for forced draught; or a small boiler can be obtained locally.

Should these recommendations meet with approval, the selected firm would supply detail, dimensioned drawings and all material required from England, such as * firebricks and fireclay for the furnaces and flues, ironwork, etc. A weighing machine, level with the roadway, should also be asked for that the contents of each cart may be weighed on entering the premises. A ground plan and cross sections of the proposed site should be sent with particulars of the required number of furnaces, height of chimney, etc.

FINANCIAL.

The following is a comparative cost of the two schemes in accordance with the above recommendations:—

	Warner.	*Horsfall.*
Four furnaces with flues,...@ £299.15.0 each =	£1,199. 0.0	@ £387.11.6. each = £1,550.6.0
Forced draught, ...	475.10.0	270. 0.0
Item *A*,.....	£1,674.10.0	£1,820. 6.0
Chimney, ...	£2,100. 0.0	£ 930. 0.0
Dust-catcher, ...	Included in furnace.	321. 5.7
Item *B*,.....	£2,100. 0.0	£1,251. 5.7
Buildings, ...		£3,470. 3.1
Floor over cells, ...	£3,585. 0.0	678.14.4
	£3,585. 0.0	£4,148.17.5
	4 cells instead of 10	4 cells instead of 12
	$\frac{2}{5}$ of £3,585. 0.0	$\frac{1}{3}$ of £4148.17.5,
Item *C*,.....	£1,434. 0.0	£1,382.19.2.

SUMMARY.

	Warner.	*Horsfall.*
Item *A*, ...	£1,674.10.0	£1,820. 6.0
Item *B*, ...	2,100. 0.0	1,251. 5.7
Item *C*, ...	1,434. 0.0	1,382.19.2
	£5,208.10.0	£4,454.10.9

From which it appears that for a four-celled Destructor, the scheme of the Horsfall Syndicate is the cheaper of the two.

Estimated cost.

Taking the above cost of the Horsfall scheme, namely,.....	£4,454.10.9
and adding—Weighing machine, say, ...	100. 0.0
—Freight of materials from England, say,.....	360. 0.0
—Extra materials and freight, say, ...	120. 0.0
Gives a Total,.....	£5,034.10.9

Bearing in mind the cheapness of labour in Hongkong compared with England a ratio of 10 to 1 will certainly cover the cost in converting the above into dollars, probably 8 to 1 would be nearer.

£5,034 10.9 @ £1 = $10,.....	$50,345.37
Add Preparation of Site and Approach Road, say,.....	2,000.00
Quarters for Overseer and Attendants, say, ...	6,000.00
Total Estimated Cost,.....	$58,345.37

* NOTE.—In the estimates attached, firebricks with freight for the chimney are included; it is specially important to have the very best properly-moulded firebricks for the furnaces and flues, but for the chimney where the heat is not so great, firebricks of local manufacture would probably be found cheaper.

Staff.

To work four cells the following staff would probably be required for each shift:—

One Engine Driver who would also act as Foreman.
One Coolie to assist him.
Two Stokers to attend to the furnaces.
One Feeder to feed in the refuse.

There should be three shifts. The whole might be under the charge of an European Overseer or Nuisance Inspector, whose duties would be arranged to fit in with the required supervision, and who would probably be only too glad to undertake it, if comfortable quarters are provided. In the first instance, constant supervision would be necessary, but this could probably be dispensed with gradually as the attendants become used to the work.

Upkeep.

The Horsfall Syndicate estimate the "annual cost of repairs to the furnaces, based upon experience in this country, will not exceed £3 to £5 per cell." Assuming the latter figure correct then £5 = $50 × 4 (cells) = $200 per annum.

There will also be the clinker to dispose of amounting to, say, ⅓rd of 24 tons = 8 tons per day.

Cost of Burning.

The estimated cost of burning 24 tons of refuse per diem, irrespective of the cost of collection, is—

Labour.—3 Engine Drivers, ...	@ $15	per month	$ 45.00	
—3 Coolies, ...	@ $ 8	,,	$ 24.00	
—6 Stokers, ...	@ $10	,,	$ 60.00	
—3 Feeders, ...	@ $ 8	,,	$ 24.00	
			$153.00	$5.10 Cost per day.
Disposal of Clinker 8 tons @ 25 cents per ton, ...				2.00
Upkeep. Repairs @ $200 per annum, ...				.55
Oil and sundries, say, ...				1.00
Total Estimated Cost per day, ...				$8.65

24 Tons @ $8.65 = 36 cents per ton or about 8⅝*d.* which compares very favourably with the cost in England. This figure would, of course, be reduced if the furnaces are capable of burning more per diem.

CONCLUSION.

In conclusion, I would state that I have visited furnaces at—

Ealing, Whitechapel, Shoreditch and Liverpool constructed on the "Fryer" principles as carried out by Messrs. MAULOVE, ALLIOTT & Co.
At Hornsey and Poplar constructed by Messrs. GODDARD, MASSEY AND WARNER.
At Edinburgh and Bradford constructed by the Horsfall Syndicate.
At Leyton constructed by Messrs. BEAMAN AND DEAS.
At Manchester constructed on the "Whiley" principle; and I wish here to acknowledge the great courtesy and kindness I have met with from the Engineers and others connected with the Cities and Vestries as well as from the representatives of the four firms who were asked to tender.

I append to this Report—

Appendix 1.—Specification, with covering letter, and correspondence with the four firms asked to tender.

Appendix 2.—Report on Refuse Destructors by the Medical Officer and Engineer to the London County Council.
Report of the City Engineer of Newcastle-upon-Tyne of the year ending March 25th, 1898.
Tests of Destructors at Bradford, Hornsey, and Kurrachi.

Appendix 3.—Drawings, Specification and Estimate by Messrs. GODDARD, MASSEY AND WARNER.

Appendix 4.—Drawings, Specification and Estimate by the Horsfall Syndicate.

J. R. CROOK,
Associate Member, Institute Civil Engineer,
Fellow Sanitary Institute.

December 3rd, 1898.

Appendix I.

8, FIELDING ROAD,
WEST KENSINGTON, LONDON, W.,
September 7th, 1898.

SIR or GENTLEMEN,—Herewith enclosed I send Specification for a Refuse Destructor for Hongkong and should be glad to receive plans, sections and tender from you.

As stated in the Specification, it has not yet been decided to erect a Destructor, but I am now reporting on the matter and purpose attaching such plans, sections and tenders as I may receive to my report.

Should you decide to tender I should be glad to receive same with all particulars, plans, &c., by November 1st.

Yours faithfully,

J. R. CROOK,
Executive Engineer, Hongkong P.W.D.

Copy sent to—

Messrs. GODDARD, MASSEY & WARNER, Nottingham.
THE BEAMAN & DEAS SYNDICATE, LD., 32, Victoria St., Westminster.
Messrs. MANLOVE, ALLIOTT & Co., LD., Nottingham.
THE HORSFALL FURNACE SYNDICATE, LD., Leeds.

Proposed Refuse Destructor

FOR

THE CITY OF VICTORIA, HONGKONG.

General Specification.

1. The site will probably be on a hillside, but for the purposes of this tender it may be assumed to be level, with a hill at the back where an inclined road may be cut to the level of the top of the furnaces. The whole of the works should, if possible, be arranged on a site 300 ft. long by 100 ft. broad, but additional length may be obtainable.

2. The works must provide for the disposal of 90 tons of refuse per diem. This refuse is of poor quality consisting of vegetable matter and cooking refuse, road sweepings from Macadam roads (there is no horse manure in this), rattan shavings, paper, rags, &c. There are no ashes in the refuse.

Forced draught should be provided and particulars should be given as to whether it is proposed to use a steam jet or fan.

3. The Destructor will be required to work continuously, but may be shut down perhaps twice a year. Arrangements must be made by which any of the furnaces may be shut off for repairs without stopping the rest. The works must also be so designed that steam can be constantly supplied, and to ensure this, the boilers should be in duplicate.

4. The flues and chimney must be so arranged that the boilers may be kept constantly working, even though all the destructor furnaces be shut off, and space must be provided for additional furnaces in the proportion of 30 % of the number now considered necessary.

5. The boiler shall be sufficient to supply 100 H.-P. and shall be in duplicate. Such buildings shall be arranged and tendered for as are considered necessary to cover the furnaces and boilers.

The position of a separate building should also be shewn on the site, to accommodate two 50-H. P. horizontal engines and two dynamos supplying 30 H.-P. each, but no tender is asked for this building or for the machinery.

6. In designing the destructor buildings, chimney, &c., it must be borne in mind that the Colony is visited annually by typhoons; everything must therefore be of the most substantial character.

All exterior walls of buildings shall be not less than 14-in. thick.

Roofs must be securely fixed to the walls and must project as little as possible beyond them. The usual local roof covering is double roll and pan tiles.

7. The dust carts for collecting the refuse contain about 2 cubic yards each, and are drawn by manual (coolie) labour. The incline to top of furnaces should not be steeper than 1 in 20 and a sum of Thirty Pounds (£30) may be allowed for constructing same.

Arrangements should be made to avoid a double handling of the refuse at the works, either by dumping it directly from the carts into trucks, as in Boulnois' and Brodie's charging apparatus, or by some similar scheme.

8. It is proposed to utilize the furnaces and provision must be made accordingly—

(*a.*) To cremate carcases of cattle (this will only be necessary occasionally).
(*b.*) To cremate, or dry for manure, offal from the Slaughter-Houses.
(*c.*) To destroy mattresses and infected clothing.
(*d.*) To supply heat for a 100-H. P. boiler.

Note.—It is proposed to use this boiler to supply steam for the following purposes, which are stated for guidance and not for an estimate.
(i.) For heating water for use in the Slaughter-Houses.
(ii.) For a disinfecting plant.
(iii.) For driving an engine of 50-H. P.

9. In submitting the plans and tender the following particulars should be given :—

(*a.*) The quantity of refuse which will be guaranteed to be burnt per furnace per diem.
(*b.*) The total H.-P. which it is estimated can be obtained from the furnaces.
(*c.*) The type of boiler which it is proposed to fix. A price should, however, be quoted for both a Lancashire and a Water-tube boiler though it does not follow that either of them will be adopted.
(*d.*) The proposed height of chimney. It must be remembered in designing the chimney that it will probably be close to the Slaughter-Houses and that no dust must escape.
(*e.*) The estimated annual cost of repairs per furnace.

10. The estimated cost of the works should be given in detail under the following headings :—

(*a.*) Cost of furnaces and flues.
(*b.*) Cost of chimney.
(*c.*) Cost of destructor buildings.
(*d.*) Cost of boilers.
(*e.*) Freight of special firebricks, boilers, iron-work, &c., to Hongkong.
(*f.*) Cost of such special materials with freight as may be required for repairs to furnaces, in the proportion of 30 °/₀ additional to that shipped from England for carrying out the works.

Note.—Ordinary bricks and an average quality firebrick can be obtained locally, but all special firebricks for the furnaces and hottest parts of the flues must be shipped from England.

11. The estimate is to be in Pounds sterling, based on the assumption that the furnaces are to be erected in London, and the freight of special material to Hongkong should be added at the end.

12. It has not yet been decided to erect a Destructor in Hongkong, and no guarantee is given that any tender will be accepted. The plans and estimates may be of a preliminary character, but the details given of working and cost must be as accurate as possible.

J. R. CROOK,
Executive Engineer,
Hongkong Public Works Department.

APPENDIX 2.

Not Printed.

Appendix 3.

NOTTINGHAM, *November 1st*, 1898.

J. R. CROOK, Esq., C.E.

DEAR SIR,—We have now much pleasure to hand you Specification, Estimate, and Drawings for proposed Destructor Plant for the City of Victoria, Hongkong.

We have gone into this scheme with a great amount of care and we think we have been able to give you such machinery that would work successfully if adopted.

Our reason for coming to this opinion is based upon the successful results we have obtained with a similar class of Plant erected in a somewhat similar climate and we believe that no other specialists of this class of machinery have had such good results.

Among such Plants we have erected, is one for the city of Kurrachi, India, where the Destructor is dealing with the refuse at the rate of about 11 tons per cell.

We are equally successful in the City of Durban, South Africa, and as a good proof of the work done in that part of the world we are at the present time engaged in the execution of a contract for a Destructor Plant to be erected at the City of East London, Cape of Good Hope.

We are also entrusted with a contract for 12-Celled Destructor, at the present time being erected at the City of Madras, India, which order was brought about after full investigation by Mr. ELLIS, the Engineer, who not only saw various Plants at work, and also took into consideration the class of Refuse to dealt with.

We enclose a list of the cities and towns where our Destructors have been erected, from which you will notice that they have been extensively used in Great Britain, and we think we are right in saying that we have erected more Destructors than our competitors. Amongst them is a 10-Celled Destructor with Boilers and Chimney Shaft for the town of Plymouth, a 4-Celled Destructor for the town of Torquay, a 6-Celled Destructor for the town of Hartlepool, a 10-Celled Destructor for the city of Sheffield, this is a repeat order after working a 6-Celled Destructor supplied by us for two years and is acknowledged to be the lowest in cost in dealing with Refuse to any in England; an additional Destructor which is a repeat order for the city of Bath, a Destructor for the town of St. Annes on Sea, and we have just completed a large installation in the District of Poplar, London, and also Destructors at Bury, Birkenhead and Handsworth, Birmingham.

We enclose a report issued by the City Engineer of Sydney who went closely into the matter of Destructors when on a visit to England, which may be useful and interesting to you with regard to the amount of work done at different towns in England and the Continent.

Upon reference to our Estimates and Plans you will notice:—

1st:—We have arranged for a 10-Celled Destructor which is equal to 9 tons per day per cell whereas recent Destructors are dealing with from 10 to 11 tons per day so that you will have a large margin to turn upon.

2nd:—We have arranged for Forced Draught by Air Pressure as we have found from experience that it is more economical.

3rd:—The Destructor is arranged so that any cell can be shut off as desired and also any cell can be closed at any time when cleaning the cells or clinkering.

4th:—You will see by the plan that we have provided sufficient space for an addition of 30 per cent., in the capacity of the Plant.

5th:—The Boilers are each equal to 100 H.P. calculated in the usual manner of Boiler Power and the Engine House is of the size required.

6th:—We enclose a drawing of Chimney which will show that there is ample strength to withstand the usual wind pressure in Hongkong, and the Buildings, Walls, &c., have been designed with extra strength as mentioned in your conditions.

The whole of the other conditions mentioned by you have been carefully considered and the scheme has been produced upon those lines, and we append drawings:—

1st:—Showing General Arrangement of the proposed Destructor and Works.

2nd:—Refuse Destructor Plan and Section.

3rd:—Elevations and Sections.

4th:—Elevation of Boilers.

5th:—Chimney Shaft 180 feet high.

We shall be pleased to go further into the matter if desirable, and our Mr. WARNER will do the pleasure of calling to see you when in London and will then be able to explain any part of the Scheme and give you his best personal attention.

We are, dear Sir,
Yours very Truly,

GODDARD, MASSEY & WARNER.

SPECIFICATION

OF

WARNER'S PATENT "PERFECTUS" DESTRUCTOR WITH MACHINERY, CHIMNEY SHAFT, &c.

FOR THE

CITY OF VICTORIA, HONGKONG.

Destructor Cells.

The Ironwork for a 10-Celled Warner's Patent Destructor consisting of special cast iron facia plates forming top fronts right and left hand.

The fronts to be fitted upon panel plates to be supported upon cast iron curb plates which also form the ashpit fronts. The above cast iron work is securely bolted and braced together by bolts 1″ diameter with cast iron washer plates.

The front facia plates are provided with half round sliding rails supported upon cast iron ribs having clearance to allow the passing of sliding doors.

The Furnace Doors of special construction having backs to receive wrot iron plates secured by set screws, each door fitted with two grooved pulleys and turned screw axle of suitable curve to the sliding rails.

The upper parts of the cells are supported by channel iron Girders having holes to receive the tie rods and strengthened by cast iron cover plates made of a section to fit the channels and ribbed and bored to form a secure bed for the tie rods.

The ends of the cells are supported by Buckstaves prepared for tie rods.

The Channel Girders and buckstaves are placed to allow the tie rods to miss the internal parts of the cells.

The dead plates of cast iron, girder section having ribs and also perforated rebates to receive the ends of the firebars and lever brackets to attach the rocking gear.

The furnace mouths are of cast iron and fitted to support the firebrick arches with provision for expansion and contraction and allow space for the cells being 6 feet wide.

The firebars are of special cast iron with teeth edges and trunion ends and are of the rocking type. Each furnace cell to contain about 40 superficial feet. The lower part of each firebar to have projections to attach the movement gear and each cell provided with side bearers and the firebars to rock in suitable bearings, each cell is also provided with a back bearer of cast iron.

A cast iron hopper with wrought iron door is provided for charging each cell.

Also a quantity of bolts, nuts and washers of various sizes making a complete set of ironwork for a 10-Celled Destructor.

Brickwork.

The brickwork to consist internally of 9″ firebrick reverberatory arches, the top part of each arch supported upon side walls of purpose-shaped bricks.

The front part of each arch to extend through the outside walls to ensure firmness, including cutting to receive the furnace mouths dead plates, firebar bearers and feeding hoppers. The arches to be provided with outlet openings for products of combustion exit, and each arch set on an incline, the lower end finishing over the dead plates.

The centre walls at the back of the arches to be constructed in firebrickwork well bonded to the arches and provided with outlet flues from each cell.

The drying hearths to be also of firebrick, paved and grouted in fireclay and extending from the back of firebars to the centre wall of furnace.

The main arch lined with firebrick and having supports on side wall, also lined with firebrick.

The end wall to be well bonded into the arch and side walls and formed to receive the cast iron frame and main flue door.

The outside walls to be of ordinary brickwork, consisting of front and back walls with firebrick footings. The joints to be neatly formed and cut with arches and arranged to receive the cast iron facia plates, panel plates, and curb plates to ashpits also the tie rods, channel irons and buckstaves.

The ashpits to be constructed in ordinary brickwork, having thick side walls.

The bottom of each to have brick paving inclined towards the front of the furnace.

The top of the Destructor to be paved with special hard selected bricks and to be cut and fitted round the edges.

Flues.

One Bye-pass Flue about 30 feet long, including the usual foundations, the flue to be constructed in firebrick inside and ordinary brickwork outside : also main flue to chimney.

Tools, etc.

Two Clinker Barrows and two sets of Feeding and Firing Tools complete.

Dust Trap.

One Special Dust Trap similar to those used at Hornsey, etc. complete with cast iron doors and frames, and fitted with baffle plates.

Multitubular Boilers.

Two Multitubular Boilers of 100 H.P. 6′. 6″ dia. 15′. 0″ long with Water Drum 3′. 0″ dia. 9′. 0″ long complete with all mountings and fittings.

Brickwork in Boiler settings complete with usual foundations.

Main Flue Dampers, No. 4 Boiler Cradles, No. 2 sets Smoke Doors, No. 2 sets Roof Tees, No. 2 Blow Off Pit Frames and Lids.

Two Donkey Feed Pumps, Steam Cylinder 4″ diameter, Ram 2″ diameter × 3″ stroke complete with bolts.

C. I. Coupling Steam Main to Boilers.

W. I. Piping, Suction, Delivery Steam and Exhaust Piping to No. 2 Pumps.

Two Foundation Stones and Concrete to Pumps.

Two Special Firegrates to Boilers 7′. 6″ long 2′. 9″ wide complete with firebars, bearers, fronts and doors.

Two sets Firing Tools and No. 2 sets Cleaning Tools.

Chimney.

Brickwork and Ironwork in Chimney 180 feet high with firebrick lining 60 feet high, 6 feet internal diameter complete with main flue door, Air Bricks, Lightning Conductor, Stone Cap, &c., delivered and erected London.

Buildings.

Ironwork, Excavation, Concrete, Brickwork, Stone Sills, Windows, Doors, &c., in Main Destructor Building 71 feet 6 inches × 53 feet. Roof in 2 Bays carried by Lattice Girder, double roll of pan title covering, steel principals, gutters and down pipes.
Do., do., in Engine and Fan House, 33 feet 6 inches × 19 feet.
Do., do., in Boiler House, 23 feet 3 inches × 19 feet.
Two Stoking Pits to Boiler Firegrates.
One Lean to Roof to Boiler Firegrates, 10 feet 6 inches × 7 feet.
Delivery and Erection London.

Inclined Road.

One Inclined Road to Cells.

Forced Draught.

Two Coupled Horizontal Engines, Cylinders 8″ diameter, 12″ stroke complete with fly wheel, governor and holding down bolts.
Two Sturtevant "No. 10" Monogram Blowers.
Two sets Earthenware Pipes with C. I. Furnace parts and outlet shutters to No. 10 cells.
One C. I. Exhaust Pipes to Engines, Steam Ditto.
W. I. Piping, Drains to Engines.
One 2½″ diameter Shaft 25 feet long and No. 2 Collars.
One 2½″ diameter Coupling to 25 Ditto complete.
3 Wall Brackets complete with C. I. Washers, Bolts and Plummer Block.
One 2½″ diameter Plummer Block complete, with sole plate and bolts.
Three Pullies various sizes.
Three Belts various sizes.
Four Foundation Stones and concrete to No. 2 Engines, and No. 2 Fans.
Delivery and erection London.

Freight to Hongkong.

Destructor, Flue, Firegrate Ironwork,	£	186.14. 0
Columns, Joists, Girder, Roofwork,		
Engine and Pumps,		14. 2. 0
Boilers,		52.10. 0
Windows,		8. 3. 0
Firebricks,		437.10. 0
Total,	£	699. 1. 0

Freight and Cost of Repair Bricks.

8,000 Firebricks,	£	32. 0. 0
Freight to Hongkong,		70. 6. 0
Fire Bars and Tools,		50. 0. 0
Total,	£	152. 6. 0

Summary.

Furnaces and Flues,	£	2,522. 0. 0
Forced Draught,		475.10. 0
Boilers,		967. 0. 0
Chimney,		2,100. 0. 0
Buildings,		3,585. 0. 0
Inclined Road,		30. 0. 0
Freight of Materials,		699. 1. 0
Cost and Freight of Repair Bricks,		152. 6. 0
Total,	£	10,530. 0. 0

GODDARD, MASSEY & WARNER.

J. R. CROOK, Esq., C.E.

TRAFFIC STREET,
NOTTINGHAM, November 14th, 1898.

Proposed Destructor for Hongkong.

DEAR SIR,—With further reference to the above we find that in the items as to the cost of freight we omitted for Columns, Joists, &c. the sum of £42 which please add in making a total cost for the freight £741.

We have gone carefully into the cost of supplying waggons to make the scheme so that the refuse may be tipped into the waggons instead of upon Destructor, and the refuse fed into the Destructor as desired, similar to the arrangement at Liverpool which will consist of 20 Waggons, Tram Rails, Wheel and Chain Gear with Brackets and Pullies making the whole system complete, will add to the estimate £350 which would make the total amount for 10-Celled Destructor complete £10,880 + 42 = £10,922.

MR. WARNER desires us to say that he will be in London on Thursday and will be glad if you will meet him at Fenchurch Station at 11.40 a.m. when he will be pleased to go with you to Poplar and show you the whole arrangement of the Works.

We are, Dear Sir,
Yours very Truly,
GODDARD, MASSEY & WARNER.

J. R. CROOK, Esq., C.E.

Appendix 4.

2nd November, 1898.

DEAR SIR,—Herewith we have pleasure in handing you our tender and brief specification for the Hongkong plant. We believe that we have provided for everything necessary for the job, and that it can be carried out on the basis of our scheme, without extras, unless additional foundations are necessary.

The consumption of refuse which we are prepared to guarantee is 7½ tons per cell per 24 hours. Our usual guarantee in this country is 10 tons, and we frequently exceed this amount by a good deal, so that we consider, especially in view of our Continental experience, that 7½ tons will be a safe figure for Hongkong refuse.

We trust that you will find everything in order and that the submission of this scheme will assist your Municipality to arrive at a decision to erect a Destructor, and that we will be entrusted with the contract. We have taken considerable pains to make a thoroughly satisfactory scheme and one suitable for your purposes.

We are, Dear Sir,
Yours faithfully,
THE HORSFALL FURNACE SYNDICATE, LTD.,
F. L. WATSON,
Manager.

J. R. CROOK, Esq.,
Executive Engineer,
Hongkong P. W. D.

(Enclosures.)

2nd November, 1898.

Proposal for a "Horsfall" Destructor for the Burning of Town Refuse

FOR

THE CITY OF HONGKONG.

Specification.

The Plant is to consist of a complete installation of 12 Cells or Furnaces for the burning of refuse on the "Horsfall" Patent system, and is so arranged that the Cells and Boiler power can be extended as required.

Cells or Furnaces.

These shall be erected according to designs covered by the "Horsfall" Patents, by which means the greatest efficiency is secured in the burning of Town Refuse, each Furnace having a grate area of 30 square feet, with a drying hearth at the back. They shall be arranged back to back in two rows of Cells.

Forced Draught.

The draught shall be forced by 2 Schiele Fans, driven by Steam Engines placed as shewn on drawing and arranged so that the whole of the air for combustion is forced by way of the Blast Flue situate between the rows of Cells through our Patent iron Side Boxes, and thence into the Ashpits below the Grate Bars. The Feeding Floor is thus ventilated, and the air heated before entering the fire.

Front Flues.

The only openings for the escape of the products of combustion shall be in the front, over the Clinkering Door, so that all the fumes given off by the green refuse in drying have to pass forward and over the hottest part of the fire before they can escape to the Chimney, and are thus thoroughly "cremated" within the Furnace itself. From the Front Flues the gases pass along the Cross Flues, and thence by the Downtakes into the Main Flue.

Grate Bars.

The Grate Bars are to be of our most improved construction, with fine air spaces to prevent combustible material from falling through before being burnt.

Brickwork.

The Furnaces to be built of good local red bricks, faced on the outside with picked stock facings. The Furnaces and Flues to be lined with our Special Brand of Ganister Bricks and Blocks; and the Ashpits and Air Ducts to be lined with seconds Salt-Glazed Bricks, set in Portland Cement mortar.

Ironwork.

The Doors and Frames to Ashpits, Front and Back Dead Plates, Grate Bars and Bearers, Clinkering Doors and Frames, Flue Cleaning Doors and Frames, Side Boxes and Trumpets, and Feed Hole Doors and Frames, shall be all substantial Castings, properly fitted together. The Clinkering Doors are of an improved pattern, with vertical lift and balance weight.

Stays.

The Furnaces are to be strongly stayed with Channel Irons, 12″ × 3½″ and 6″ × 3″, Girders 8″ × 4″, and Tie Bolts 1½″ diameter, with enlarged ends and strong Washer Plates.

Boilers.

Alternative boilers are provided, either of the water tube type or of the Lancashire type.

Water Tube Boilers.

These, if adopted, shall be two in number, BABCOCK AND WILCOX' patent, each boiler 1,218 sq. feet of heating surface suitable for a working pressure up to 120 lbs. per square inch provided with first-class boiler fittings of best make, including safety valves, water gauges, steam gauges, blow-off valves, etc., etc. The boilers to be constructed to Messrs. BABCOCK AND WILCOX standard specification, of which a copy will be provided if desired.

Lancashire-Boilers.

The Lancashire boilers, if adopted, shall be each 30 feet long by 8 feet diameter, of first class construction throughout, made entirely of mild steel plates, and suitable in every respect for a working pressure of 120 lbs. per sq. inch. Each boiler shall be provided with safety valve, junction valve, steam gauge, water gauges, blow-off valve, and all other fittings of first-class make, and a copy of the Makers' specification shall be provided if required.

In each of the above cases, one boiler is intended to provide the requisite steam, the other to act as a stand-by in case of emergency.

Boiler Settings.

These shall be constructed on the most approved principles, and lined throughout with firebrick.

Shutting of Cells.

Any cell can be shut off for repairs without stopping the rest, by placing an iron plate or a quarry in the take-away flue at the top of the furnace. The cell will then be completely isolated and no cold air can pass through into the flues.

Feeding Arrangements.

These shall be of our latest patent type, the refuse being tipped out of the collecting carts into tipping waggons running on a set of sidings provided on the loading and storage bay. Rails are provided along the platforms and over the tops of the furnaces, and the refuse is tipped out of the tipping waggons into the charging holes. There is thus no handling of the refuse.

Forced Draught.

This shall be provided by means of two Schiele fans, 30″ diameter, driven independently by means of two Marshall's vertical high speed engines, 6½″ diameter by 10″ stroke, fitted with high speed Pickering's governor, and usual fittings of best quality.

Boiler Furnaces.

The boilers, whether Lancashire or water tube shall be provided with separate furnaces for coal firing if required, provided with forced draught. In the case of the water tube boilers, our patent side boxes shall be introduced. The forced draught to the boilers shall be provided by means of our patent steam jet apparatus.

Feed Pumps.

One Worthington Duplex Feed Pump $4\frac{1}{2}'' \times 2\frac{3}{4}'' \times 4''$ with brass lined water ends shall be provided, with all necessary fixings and fittings.

Tank.

One wrought iron tank of 1,000 gallons capacity, fitted with ball-cock and overflow together with all water pipes from tank to pump, and pump to boilers, steam pipes from boilers to pump, and all necessary cocks and fittings, the water supply to the tank to be provided by the Municipality.

Economiser.

One Green's patent Economiser of 224 pipes shall be provided and fixed.

Dust-catcher.

One of our patent centrifugal Dust-catchers 20 feet diameter, lined with best firebrick and provided with iron bands and cleaning doors shall be provided.

Chimney.

One brick chimney 100 feet high by 6'. 6" inside diameter having an octagonal shell, lined with circular firebrick lining from the bottom to the top, strongly constructed throughout and fitted with lightning conductor, shall be provided.

Furnace for Drying Offal.

A furnace for this purpose, heated with hot gases from the destructor shall be provided as shown upon the drawing. A suitable mattress chamber shall be provided. This chamber will also be suitable for burning putrid meat, carcases, etc.

The inclined Roadway and paving of tipping platforms shall be provided by the Municipality. The iron work construction of the tipping platform as well as the construction and laying of rails upon the loading and storage bay, and platforms over furnaces, is, however, included in this tender.

Capacity of Cells.

The cells are guaranteed to burn $7\frac{1}{2}$ tons per cell per 24 hours of the Ordinary Hongkong City refuse, when properly managed by skilled stokers. It is difficult to estimate the total horse power which will be available, which will entirely depend upon the calorific value of the refuse. The latter will probably be low, but we think there will be something like 200 I.H.P. available if required.

Repairs.

The estimated annual cost of repairs to the furnaces, based upon experience in this country, will not exceed £3 to £5 per cell.

Building.

This shall be of brick with iron roof, covered with local tiles. The design shall be as shewn on drawing. No external walls to be of less than 14 inches, all the walls of buildings to be constructed of local brick. A ventilator, louvre boarded, running the whole length of the building shall be provided with steel and iron principals, the foundations to each part of the work which are included in this tender are clearly shewn upon the drawing.

Any additional foundations which may be found necessary shall be measured up and allowed for at current local rates.

THE HORSFALL FURNACE SYNDICATE, LIMITED,
16*th November*, 1898.

DEAR SIR,—In reply to your favour of the 1st, we beg to enclose herewith a revised summary of the prices for our destructor scheme for Hongkong, in accordance with your requirements.

The item "drying oven" is the offal-drying chamber, shewn on plan. You are also correct as to the feeding arrangement, two back to back cells being fed from the same opening.

In case of wishing to work one cell, with the opposite one stopped, all that is necessary is to put in a temporary brick stopping at the back of the cell which is not to be worked. This will prevent the heat or the refuse from passing from one cell to the other. With both cells working, the feed opening might be filled with refuse at each charging, and the refuse would be pulled forward on to the fires as required.

The *exact* arrangement shewn is not erected anywhere at present, but it is practically the same as our hand-fed back-to-back type, which is working so successfully at Edinburgh, Bradford, etc., almost the only difference being in the fact that the refuse is tipped direct into the feed hole, instead of being tipped first on top of the furnaces, and then thrown into the feed hole by the men.

There is not the slightest doubt as to the effective working of the arrangement, which we are about to put into a most important contract in London.

We think the freights which we have put down are rather high, and have no doubt that if we secure the contract we shall be able to obtain lower freights, so that you can take the item for freights as being subject to revision, in the event of our obtaining the contract.

Yours faithfully,

THE HORSFALL FURNACE SYNDICATE, LIMITED,
F. L. WATSON,
Manager.

J. R. CROOK, Esq.

HONGKONG REVISED SUMMARY. NOVEMBER 14TH, 1898.

			£ s. d.
Item *A.*			
1	12	Horsfall cells including flues and Firing tools, ...	4,380.18. 4
2	1	Dust-catcher, ...	321. 5. 7
3		Charging platform over furnaces, ...	678.14. 4
4		Patent feeding arrangements, ...	480. 0. 0
5		Drying oven, ...	200. 0. 0
6		Engines and fans for forced draught, ...	270. 0. 0
7		Patent suspension railway on clinkering floor, ...	300. 0. 0
		£	6,630.18. 3
Item *C.* 1		Destructor building, ...	3,470. 3. 1
2		Construction of tipping platform with tramways, ...	825.12. 8
3		64 Tipping waggons, ...	724.14. 3
		£	5,020.10. 0
Item *D.* 1		Two Babcock and Wilcox Boilers with setting, etc., and fixtures,	1,388. 2. 2
2		Forced Draught to Boilers, ...	90. 0. 0
3		Economiser and setting, ...	740. 9. 7
		£	2,218.11. 9
		£ s. d.	
Item *E.* 1		Freight of special firebrick and clays, 250 tons 1/5/- 312.10. 0	
		Insurance, shipping, stamps, etc., ... 62.10. 0	
		375. 0. 0	375. 0. 0
2		Freight of boilers,--	
	2	Drums, $\frac{24' 6'' \times 3\frac{1}{2}' \times 4'.0}{40} = 17\frac{3}{20}$ tons 2/5/-... 38.11. 9	
		Tubes, $\frac{4\frac{1}{4}' \times 4' \times 18}{40} = 7\frac{3}{4}$ tons 2/5/-... 17. 8. 0	
		Balance of iron work, ...$12\frac{1}{2}$ tons 1/5/-... 15.12. 6	
		71.12. 3	
		Insurance, shipping, stamps, and other charges, approximate, ... 28. 7. 9	
		100. 0. 0	100. 0. 0
		Iron work for Furnaces, roofing (weight and measurement), approximate, ...	1,040. 0. 0
		Including all charges.	
		£	1,515. 0. 0

J. R. CROOK, Esq.,
City Engineer of Hongkong.

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Manager.