

XV.—THE LONDON AND NEWCASTLE CHALDRONS FOR MEASURING COAL

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The most comprehensive study of the development of the British coal industry is that of Nef¹ but the quantitative assessment of the development in his period, 1550-1700, is based on a transcription of the records in the Port Books in the Public Record Office and on estimates of the equivalents of the Newcastle and London chaldrons in terms of Imperial Standard (modern) tons. Statements such as "in less than a century and a quarter shipments from Newcastle multiplied nearly nineteen-fold, while imports at London multiplied more than thirty-fold"² are so much dependent on the accuracy of the base values and their conversion from Newcastle and London chaldrons into tons that a re-assessment of Nef's estimates of certain weights and measures seems called for. A foreigner, even an American, may be pardoned if he found English weights and measures confusing. In fact, Nef's definitions and assessments of the chaldrons as well as of the bushel, the stack and the rook require some corrections.

THE LONDON CHALDRON

One of the earliest measures used for the retail³ of coal is mentioned in a duty levied in the time of Henry III (1216-72) and quoted by Galloway:⁴ "For two quarters of sea-coal, measured by the King's quarter, one farthing". The standard measures of Henry III (1266) included the relationship 8 gallons=1 (Winchester) bushel; 8 bushels=1 (London) quarter. This Winchester bushel was equal to

1.00 cu. ft. so that the King's quarter was of 8 cu. ft. level capacity. The Winchester bushel was not altered until 1497 when Henry VII changed it to 1.24 cu. ft. and a quarter became nearly 10 cu. ft. ($4\frac{1}{4}$ cwt. of coal level measure, $5\frac{1}{2}$ cwt. heaped measure). That the same measure was still in use in 1543 is shown by an Act containing the words "everie quaterre of coles shall contayne in cleane coles eight bushells at the least", but for larger measure the chaldron is known at least as early as 1324⁵ for a delivery to a Durham priory and in 1367⁶ in a delivery to Windsor recorded by Taylor.⁷

The London quarter of 1266 seems to have been derived from the standard measure for wood which, after cutting, was stacked in the woods in "cords", each $8 \times 4 \times 4$ ft. = 128 cu. ft. and weighing about 2.2 tons after 6 months. Such a load could, after cutting into faggots, be carried in a four-wheeled wain and be hauled by a team of horses. As early as 1333⁸ it was usual for a "load" of charcoal to be a wain load of 14 quarters, which would settle to 12 quarters on delivery. Such a load, of 112 cu. ft. and of 0.8 tons, remained the standard in the charcoal industry for centuries.

The wood wain, filled with coal, would be too heavy a load, since coal has a bulk density roughly three times that of charcoal, and a load of 4 quarters seems to have formed the original chaldron measure for coal. The London trade in sea-coal was sufficiently developed by 1306 for a tax to be levied on it for the upkeep of Tower Bridge and in 1368, for the first appointment of "Meeters" or measurers. It should be noted that "striked" or level measure was inappropriate for coal and heaped measure was invariably used, which must have increased the capacity of a bushel measure by approximately 25 per cent. Since Newcastle coal can be taken to be of about 48 lb./cu. ft., the 32 bushels heaped measure of the fourteenth-century London chaldron would be equivalent to 1920 avoirdupois pounds each of 6992 grains (of 1340), equal to 1995 pounds of 6750 grains of Henry III, or approximately 2000 merchant pounds, and

this was taken by Nef, following Taylor⁷ and Skinner,⁹ to be the original weight of the chaldron.

The increase in the volume of the bushel in 1497 would increase the weight of coal in a London chaldron by about one quarter from 17 to 21 cwt. (modern). Nef records a test made in 1616¹⁰ in which 1 ton of Scottish coal (large) was broken to the size of Newcastle coal and found to occupy 298 gallons and the London chaldron to be equivalent to 396 gallons,* or $20 \times 396/298 = 26.6$ cwt. In 1830, just before the retail sale of coal by measure was abandoned, a committee found the London chaldron to be equivalent to $25\frac{1}{2}$ cwt.¹² The report of the same committee stated that the London chaldron consisted of 4 vats, each of 9 bushels and each of these of 9 gallons, though the date when this standard was introduced is not given. A 36-bushel (324 gallons level measure) chaldron instead of a 32-bushel chaldron (256 gallons) would give an increase of 26 per cent, *i.e.* from the 21 cwt. of 1497 to 26.2 cwt. This increase had already occurred by 1616,¹⁰ and in fact by 1595. The latter is proved by the reply of two coal owners, Henry Mitford and Henry Chapman,¹³ to a complaint of the Mayor of London regarding the price of coal: "for the space of these seven yeres last past, a chalder of Coles Newcastle measure hath not been raised in price above two shilling, w^{ch} is 16d. in a London Chalder"; since the Newcastle chaldron is known then to have been 42 cwt. (see later) this would make the London chaldron 28 cwt. or, using the more accurate ratio of $1\frac{5}{8}$ shown to be established in 1616,¹⁰ $25\frac{3}{4}$ cwt. The statement¹⁴ (which Nef dated 1600¹⁵ but from internal evidence on the price of coal is more probably 1590) that "The (Newcastle) chaldron, 54 Winchester bushels, within 10 years was 5s. at Newcastle but is now 9s." and the ratio of reference 13 make

* 1 ton occupying 396 gallons would give a bulk density of 48 lb./cu. ft., an acceptable figure, showing that these gallons (or 49.5 bushels) are level measure and that the heaped portion is more than one third in excess of the 36 bushels (level measure) which we know the London chaldron was in 1664-5.¹¹ The heaped portion as a percentage of the level measure increases with the diameter of the measure. A heaped vat of 9 bushels would give at least one third excess measure in the heaped cone.

the London chaldron 36 bushels at that time. Since Nef's earliest record of shipments into London is for 1580, one cannot quarrel with his use of $1\frac{1}{3}$ tons as the equivalent of the London chaldron for his period, whilst recognizing that it was 17 cwt. originally, became 21 cwt. in 1497 and possibly attained its final level of about $26\frac{1}{2}$ cwt. in 1530 when, it will be shown later, the Newcastle chaldron was drastically altered.

THE NEWCASTLE CHALDRON

In the fourteenth century the coal pits at Winlaton, Whickham and Gateshead Fell on the south bank of the Tyne belonged to the Bishop of Durham and those on the north bank and west of Newcastle, at Elswick and Benwell, to the Prior of Tynemouth whilst the Mayor and townsmen of Newcastle held a grant from the King to work coal to the north and outside of the town walls. In 1368 Edward III commanded the Mayor, bailiffs and certain burgesses of Newcastle to take charge of the measurement of sea-coals and not to permit them to be loaded into ships before being measured by the standard measure, but, on representations being made, he allowed the keel measure to be used.¹⁶ The keel load at this time was 20 chaldrons (as it remained until 1529), but the Newcastle chaldron was apparently equal to 1 wain load of 17 cwt. and the keel load 17 tons, so that the Newcastle chaldron was also 17 cwt. In 1497, when the bushel increased in volume by 24 per cent, the keel load would become 21 tons and the Newcastle chaldron 21 cwt.

The keel load was the maximum daily production allowed by the Bishop of Durham in a lease of a pit in Whickham in 1356 and at Gateshead in 1364,¹⁷ whilst in a letter from the Chancellor of the Bishop of Durham to his master (Wolsey) in the period 1523-29 there is the statement "every keel containing 20 chald".¹⁸

The loading of coal from colliery staithes into keels was mentioned⁶ in 1376: "each of the said keels containing 20

chaldrons". The same record shows that 676 chaldrons (20 of which equalled one keel) in a shipment were also described as 516 chaldrons "by the long hundred" (120 chaldrons). Unfortunately some coal was lost at sea and 561 $\frac{3}{4}$ chaldrons "by London Thames measure" were accounted for as dispatched to Windsor with 28 chaldrons (1 in 20) free measure, an allowance later called "Ingrain"; freight was charged on the sum of these two items, *i.e.* on the delivered coal in terms of the London chaldron. Although it is said that part of the difference between this sum and the original 676 Newcastle chaldrons (86 $\frac{1}{4}$ chaldrons) was partly accounted for by the excess measure of the London over the Newcastle chaldron, as well as by loss at sea, the excess cannot have been great, both being approximately 17 cwt. according to the estimates already given.

It is clear from an Act of Parliament in 1421¹⁹ (the date taken by Nef for the beginning of his table) that the custom due to the King from 1268¹⁶ was 2d. per chaldron shipped, this being part of the Tunnage and Poundage Acts for port dues enacted in the reign of Edward III; the Act contains the statement that a keel ought to contain 20 chaldrons but that some had carried 22 or 23 to the defrauding of the King. It was enacted that keels had to be marked by the King's Commissioners before use for carrying coals.

Although, as previously recorded, Newcastle had in 1368 obtained the sole rights for measuring keels of coal to ensure the payment to the King of the 2d. per chaldron tax, the Bishop of Durham in 1384 obtained the right to moor ships on the south bank and to load coals without molestation by Newcastle. This right was continually disputed by the citizens of Newcastle. The last attempt to ship coal from the south bank occurred when Wolsey was both Archbishop of York and Bishop of Durham, but his downfall and death, in 1530, enabled Newcastle to obtain in that year final authority, by Act of Parliament,²⁰ to the sole rights for shipping coal from the Tyne.

It appears that this success was the occasion chosen for

the doubling of the weight of the Newcastle chaldron by making a keel load a ten, i.e. ten chaldrons, which would automatically halve the King's tax which was based on the chaldron, undefined by statute. The increase in weight of the Newcastle chaldron has usually been attributed to a desire to reduce the effect of taxation but it is more likely that this change was made to overcome the limitation of daily production to 20 old chaldrons and that the larger production possible would compensate for the halving of the tax per unit of weight. In a lease of 1530 by the Prior of Tynemouth of a mine in Elswick (for £20 *p.a.*: a relatively high rent) the output was limited to "20 chaldrons, reckoning 16 bolls to the chaldron".²¹ Since in the Charter which gave the Hostmen of Newcastle the monopoly of shipping coal from the Tyne in 1600 it is stated that "from Tyme out of mynde yt hath been accustomed that all cole waynes did usuallie cary and bring eighte boulls of coles to all the staythes upon the ryver of Tyne",²² it is clear that the Newcastle chaldron of 1530 had become two wainloads. The wain load was fixed at 7 bolls in 1678²³ and at 17½ cwt. in 1695,²⁴ which would make the 8-boll wain of 1600 and earlier 20 cwt.

The "ten" remained the basis of the orderly arrangement of shipments of coal by the factors of the Hostmen's company in the first quarter of the seventeenth century²⁵ and was subsequently used as a basis for rents for mines for wayleaves (rent for coal wains passing over other property) and staitheleaves (rent for loading points) but in this use it nearly doubled from 160 to 300 bolls in the second half of the seventeenth century and later nearly trebled to 440-450 bolls.

The final change in the weight of the Newcastle chaldron was made by calling the keel load 8 chaldrons. This seems to have been associated with the attempts of Charles I to secure a virtual monopoly of the Newcastle coal trade in 1635-6.²⁶ The original tax of 2d. per chaldron shipped from Newcastle had not been paid after 1568, but because of the

arrears Elizabeth I, in 1600, made the tax 1s.-0d. per Newcastle chaldron for coal shipped coastwise, a tax which remained in force until 1831. A tax of 5s.-0d. per Newcastle chaldron shipped abroad from Newcastle was instituted in 1600, the hostmen of Newcastle being responsible for its collection. In 1620 the export tax for coal shipped in English ships was increased by 1s.-8d. and in 1634 by a further 4s.-0d., but in 1660 it was reduced by 3s.-6d. and in 1663 by a further 1s.-8d. Thus the period 1620-60 was one of very high tax on export coal so that evasion was likely to be attempted. The records of the hostmen are surprisingly meagre for the period 1617-44.¹³ Since however records of shipments from Newcastle are missing for 1635-54, there are none to convert to tons, but the Hostmen records after 1650¹³ show clearly that there were 8 chaldrons per keel* and the date of change can be put, with Nef, as being in the period 1635-8.†²⁷ This chaldron of 52½ cwt. was confirmed and expressly stated to be three wain loads in 1678,²³ and also in 1695²⁴ when the weight was rounded to 53 cwt., which it remained until finally abandoned in the nineteenth century. Thus in 1635 the Newcastle chaldron had become three times its original size and was then twice the weight of the London chaldron measure.

The inter-relationship over different periods of time is illustrated in Table 1.

TABLE 1

CHANGES IN THE NEWCASTLE CHALDRON

Period	1 Keel =		1 chaldron =			1 Bushel in cu. ft.
	Chaldrons	Tons	Bolls	Wains	Cwt.	
1266-1497	20	17	—	1	17	1.00
1498-1529	20	21	(8)*	1	21	1.24
1536-1635	10	21	16	2	42	1.24
after 1635	8	21	21	3	53	—

* By inference

* For example, on 23 July 1651, 17 April 1656, 8 September 1667, 6 March 1672 and 8 May 1695.

† Gardner states a document of 12 Chas. I (1638) "due measure at one and twenty bolls to the chaldron".²⁷

The increase in size of the Newcastle chaldron cannot have been uniform over periods as Nef assumed. The first change (1497) occurred with the statutory increase in the size of the bushel, the second (1530) with the acquisition by Newcastle of the rights to ship coal on the Tyne, and the third (1635) when Charles I was looking to taxes on coal for increased revenue. The last two changes may be said to have been designed to reduce taxation based on the chaldron, which from its nature defeated precise definition, but they were probably designs to increase trade. The change in 1635 seems to have recognized the practice of several hostmen to charge for only 8 chaldrons in a 10-chaldron keel, a practice which the hostmen fined for this said was imposed by the shippers. Deliberate attempts to evade taxation seem to have been prevalent in the early years of the Hostmen's Company; they were countered by instructions²⁸ in 1604 to measure only by the "just and true measured Keels after the measured Chaldron" and in 1622 by a complaint²⁹ that ships were being loaded in bulk and "not by the due measure of Keels and lighters", the sale of coal then being limited to certain of the Hostmen and the instruction "all such Keels as have not been already measured this year shall be forthwith duly measured". In 1638, in addition to limiting sale of coal to six factors out of the hostmen, it was again insisted "all Keels to be measured".³⁰

Nef's estimates agree with Table I after 1635 but use a chaldron of 42 cwt. for the approximate period 1601-18: the chief disagreement (except for a gradual increase between these periods) is that he used 34 cwt. instead of 42 cwt. for his base date of 1563-4. Moreover, his basis quantity for 1573-4 (18,306 chaldrons) was taken from a MS. account of the Newcastle Corporation, an early entry of which for 1561-2 (11,927 chaldrons) he rightly criticized as being defective. Both should be ignored and a record from the Customs Account for 1549-50 for 20,804 chaldrons (43,678 tons) shipped coastwise should be accepted. Adding to this a probable 25,000 tons of coal exported gives a base of 68,700 tons, twice Nef's

estimate for 1563-4. This total is confirmed by two records for half year's shipments (winter and summer) for 1561-2 and 1565-6 which together give 39,000 tons shipped coastwise and a total shipment of 64,000 for 1574-5. Nef's nineteen-fold increase in shipments must therefore be halved, though his estimates for imports into London are confirmed.

It is preferable to use a graphical method rather than to select values for isolated years, to show the rate of increase of shipments. This method shows clearly that the date for the rapid advance in shipments from Newcastle can be put at 1580 rather than 1550-60 as suggested by Nef, thus confirming the statement of Gray³¹ which had usually been accepted by other writers before Nef. The method has been demonstrated in another paper.*

Since so many conflicting estimates have been made of the weight of the chaldron the causes of the errors are traced in an Appendix to this paper.

APPENDIX

ERRORS IN EARLIER ASSESSMENTS

Just before measures were abandoned for assessing the quantity of coal sold by retail and weight was substituted (1832) there was a select Committee on the Coal Trade which reported in 1829 and 1830.¹² The committee had a number of experiments made on Tyneside coals and found the average weight of a London chaldron to be $25\frac{1}{2}$ cwt. The weight of this measure would depend on the proportion of different sizes and on the ash of the coal. The specific gravity of Tyneside coals was shown to be 1.26 and a cubic foot of solid coal to weigh 78.9 lb. (and not 67 lb. as asserted by the Royal Society in 1675,³² a value which misled Nef),

* See *Colliery Guardian*, vol. 204 1962, pp. 301-305, 338-341.

so that the free space in the London chaldron was 38 per cent. With stacked large (Scottish, Midland) coal the free space may be similar, so that the Shropshire stack of 3 cu. yd. or 81 cu. ft. would hold 35 cwt., as did the "load" of coal in South Derbyshire* in 1693,³³ whilst the rook at Winlaton, Nottinghamshire (61 cu. ft.) would be 26.2 cwt. like the London chaldron of the same date (*ca.* 1600).

The only other reliable tests which seem to have been made are those of the commission of 1616 who, however, used level measure as already described. The assertion of the Royal Society in 1703 that the London chaldron contained 28 cwt.,³⁴ a value used by the customs for revenue purposes,³⁵ must, like their assertion already mentioned, be questioned. Taking the London chaldron as 1.0 this makes the Newcastle chaldron 1.9 instead of 2, the ratio there is good reason to believe is, on the average, valid from the date 1635. The many ratios mentioned are an indication of the lack of precision possible with measures rather than of deliberate attempts to alter either of the chaldrons.

Of the writers on the coal trade Brand (1789) introduced an error in stating that in the Elswick lease of 1530 the chaldron was to consist of 6 bolls, though he correctly had 16 in his footnote. This error was copied by Dunn³⁶ and Taylor⁷ but was corrected by Galloway.⁴

Most writers have turned to Taylor's estimate of the Newcastle chaldron but Taylor, being misled by Brand's mistake, failed to give a clear picture. He stated that in 1602 the chaldron may be assumed to have been 2.1 tons and that at this period the keel load was a "ten", or 10 chaldrons; he also stated that in 1678 the keel load was 210 bolls and was later 8 chaldrons but, because he failed to appreciate that the ten of 1602 contained 160 bolls, he misled subsequent writers. Dendy¹³ accepted Taylor's estimate of 2.1 tons for the period 1600 (when the hostmen's records began) to 1678 and 2.65 tons (53 cwt.) subsequently, despite the fact that

* Also the rook at Stanley colliery, Derbyshire, incorrectly sited by Nef in Rutland.

records he quotes for at least as early as 1651 show that 8 Newcastle chaldrons made a keel load.

Galloway came nearer to the truth than any of the writers mentioned, though his method of recording developments by centuries make his comments difficult to follow. Galloway put right Brand's mistake; he recognized the significance of the changes in 1530 and 1635 but differed from the assessment given in this paper by putting the Newcastle chaldron of 1635 as 21 bolls = 47 cwt. This error is based on the use of a table of 1829 which stated that a keel contained 8 chaldrons, and a chaldron 3 fothers = 24 bolls. Galloway failed to realize that in 1829 the wain load (fother) which had been returned to its original capacity of 8 bolls, was no longer a statutory measure, the chaldron of that date being assessed by a railed wagon made to a specified size; the boll had changed in size being only of significance in mining leases and varied in size throughout the coalfield; his estimate of the chaldron of 1635 is therefore incorrect. It cannot be too strongly emphasized that tabular statements are misleading when heaped measures are concerned.

Nef accepted Taylor's estimate⁷ that the Newcastle chaldron was originally of 2,000 lb., though he used a date of 1421 which Taylor used in another sense. Nef continued:³⁷ "thereafter its weight was continually increased by the traders in their efforts to reduce the burden of taxes on coal, until 1678, when the weight was fixed by statute at 52½ cwt". The statutory weight of 1678 was twice that of the London chaldron, a ratio which Nef shows was attained as early as 1636.³⁸

The same commission which assessed the London chaldron in 1616¹⁰ found that the ratio of the Newcastle to the London chaldron was 1½, making the Newcastle chaldron 43 cwt. Nef took these fixed values and said "for want of a better method of estimating its contents in the intervening periods I have assumed that, during these periods, it increased at a constant rate", *i.e.* from 18 cwt. in 1421 to 43 cwt. in 1616 at the rate of 1 cwt. per 8 or 9 years, and

from 43 to 52 cwt. in 1636 at the rate of 1 cwt. every 2 years.

Nef's mistake was in not recognizing the importance of the keel load, which he said³⁹ "was not a common means of reckoning quantities of coal, but . . . it may be taken to mean about 21 tons". In fact, as has been shown, it was the keel load which was the basis of the customs assessment of shipping and the Newcastle chaldron was merely a recognition of the stated number in a keel load. Until the nineteenth century coal was loaded from staithes (river loading points) into keels (barges or lighters), which after recording at the Customs at Newcastle were unloaded by hand into ocean-going ships carrying about 80 chaldrons. The coal was carried to the staithes by wains or carts until the second half of the seventeenth century, when chaldron wagons with flanged iron wheels running on oak rails gradually replaced them. The carts and wains were measured and are a valuable means of assessing the equivalent of the Newcastle chaldron: this was, in effect, equal in successive periods to one, two and, finally, three wain loads.

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- ²¹ Gibson, *History of the Monastery of Tynemouth*, II, p. 197.
- ²² Ref. 20, II, 273.
- ²³ 30 Chas. II, c. 8.
- ²⁴ 6. and 7 Will. III, c. 10.
- ²⁵ Ref. 13, p. 44 (1602), 657 (1617 N.S.), 70 (1622).
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