RCHME SURVEY REPORT

WESTERN GOODS SHED

(BARPART HOUSE)

King's Cross, London

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RCHM
ENGLAND

THE WESTERN GOODS SHED (BARPART HOUSE)
KINGS CROSS
L.B. CAMDEN
LONDON N1

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SUMMARY

The Western Goods Shed was built in 1897-9 for the Great Northern Railway Company to provide a separate facility for outwards goods traffic at its chief depot, the King's Cross Goods Yard. It was designed to bypass the delays caused by the intermixing of outwards and inwards goods traffic, both of which were collectively handled in three 1850s goods yard buildings - the Granary and two adjoining transit sheds. The Western Goods Shed formed part of a nation-wide programme of upgrading of key collection and distribution points undertaken by the G.N.R. in the late 1890s at a time when it was facing severe competition from the Great Central Railway. Designed by the company's Chief Engineer, Alexander Ross, as a simple two-level shed of about 380ft (115m) by 170ft (52m) in extent with tracks entering on both floors, it was sited over, and made partial structural use of, a disused canal basin in the southwest part of the yard. A pre-existing former coal drops building and adjoining railway viaduct were also adapted to fulfill complementary roles for the new building. In *c.*1915 the high-level shed was extended northwards through the construction of a range of timber-framed north-lit trusses, presumably to enable longer trains of waggons to be loaded up under cover. The Western Goods Shed continued to serve outwards goods traffic - and the Granary and transit sheds the inwards traffic - until 1938, when their roles were reversed. In the 1980s, when British Rail finally abandoned the site, the building was converted to light industrial and road haulage warehouse use.

The Western Goods Shed is of considerable interest as a very early example of a steel-framed building in Britain, albeit one with continued reliance on external loadbearing brick walls. It has further value in the context of railway history as it provides a fairly well preserved example of this obsolete and fast-disappearing class of building.

PREFACE

This report results from investigations undertaken from the London office of the Royal Commission on the Historical Monuments of England, under the framework of RCHME's Emergency Recording programme. The recording of the Western Goods Shed (Barpart House) in November 1998 supplements previous investigations of the King's Cross Goods Yard site carried out by the RCHME and other parties, an area that has faced development proposals since the late 1980s. The Western Goods Shed is not a listed building, but is of considerable interest in the context of the site as a whole and in the history of steel-framed buildings and of railway goods handling.

The Royal Commission is grateful to Mr Charles Hamilton of NFC Property Services for facilitating access, and providing material, including aerial photographs, useful to our investigations. We are also grateful to Philip Parsons of Steel Deck for providing a recent sketch plan of the site, and all the individuals of the various concerns currently occupying Barpart House who permitted unrestricted access for our recording. We should also especially like to thank Conrad Pointon and Matthew Shelton of Railtrack Archives, York, for locating and copying maps and drawings without which many of the findings reached would not have been possible.

HISTORY

The construction of the Western Goods Shed in 1897-9 represented the second and final episode of major development of the King's Cross Goods Yard by the Great Northern Railway Company. In the late 1890s the G.N.R. was facing severe competition from the Great Central Railway - a new player in the lucrative goods carriage trade to the metropolis that was then constructing a direct and independent line from Manchester to London.[1] The laying of this "fifth line to the north" prompted the G.N.R. into upgrading its key collection and distribution points through the buying, leasing, building and converting of suitable premises.[2] In Deansgate, Manchester, for example, the G.N.R. spent more than £1 million on a colossal new goods station and warehouse completed in 1899, designed as a multi-level rail, road and canal interchange,[3] and in Yorkshire the company acquired the Hunslet Railway, building a two-storey goods warehouse of some 300 feet by 150 feet to increase its grip in that district.[4]

King's Cross Goods Yard in the 1890s remained the established nodal point on the G.N.R.'s freight network - a sprawling area comprising some 59 acres of 1850s and '60s warehouses, sheds, stables, offices and sidings.[5] Vast though these facilities were, by the 1890s, when almost all long distance goods were sent by rail, the first generation buildings were proving inadequate in handling new (and anticipated) volumes of traffic. More precisely, there was considerable intermixing of outwards and inwards goods traffic, both of which were collectively handled by the Granary (1852) and two adjoining transit sheds (1850). As a result, considerable delays were "caused by the fouling of 'up' lines by 'down' trains and *vice versâ*".[6] To alleviate this problem, the company determined to separate the outwards from the inwards goods traffic by constructing a purpose-built shed dedicated to the former, the pre-existing buildings to be dedicated solely to handling inwards freight. This was accompanied by other minor additions and alterations to the site in the closing years of the nineteenth century, most notably the erection of a mezzanine office floor above part of the old (1850) train assembly area, the addition of a roof over the 1864-5 potato market warehouses' roadway, and the construction of a new viaduct and the re-siting of an existing one. Collectively these works embodied renewed investment in the yard by the G.N.R.

In 1897 the company appointed Alexander Ross (1845-1923) as Chief Engineer. Ross had worked his entire thirty-six year career in railways, and had ironically most recently served as Chief Engineer of the Manchester, Sheffield and Lincolnshire (subsequently, in 1899, the Great Central) Railway.[7] Plausibly Ross was appointed with a view to the immediate task of updating the King's Cross Goods Yard, for the contract and specification he drew up for one component of this - the conversion of the Western Coal Drops to be an adjunct of the new Western Goods Shed - is dated October 1897.[8]

The new goods shed Ross designed was a large [380ft (115m) by 170ft (52m)] two-level structure with tracks entering on both floors. It was sited in the southwest corner of the yard where there was a disused canal basin (1850s) for handling coal and stone. This basin was partially infilled for the project. Construction was supervised by Ross's assistant, S. Bolton, and the goods shed was brought into use on 8 July 1899, although the offices above the upper level were then incomplete.[9] Unlike some of the earlier generation of neighbouring buildings such as the Granary, it made few concessions to architectural dictates or embellishment. From an engineering standpoint it was ostensibly unremarkable; its contemporary in Manchester - representing the zenith of Victorian railway technology - having perhaps stolen the limelight, winning the plaudits of the specialist press.[10] In the Western Goods Shed, the accent is rather on resourcefulness, quality of materials and construction: Ross ingeniously adapted and manoeuvred pre-existing components for new uses (presumably for the sake of economy), whilst at the same time demanding that the quality of the new iron, steel and brickwork, as well as the overall craftsmanship be second to none.[11]

In terms of operation, the Western Goods Shed was a resounding success. J. Medcalf, then retired Outdoor Goods Manager for the G.N.R., remarked in 1900:

> The new goods shed for down traffic has obviated many difficulties, and trucks for all parts of the Great Northern system are now loaded up simultaneously and dispatched in rapid relays to Clarence Yard, Holloway, for marshalling into the through trains for the West Riding, Manchester, Liverpool, Ireland, and the Lancashire district, Scotland and the North Eastern line, Nottingham and Derbyshire, Staffordshire and the potteries, Norwich, Yarmouth, and the north Norfolk district, with of course Lincolnshire and the home counties, including such desirable nursery grounds for business as Cambridge, Luton, etc. All sorts of commodities "strut their brief hour" upon the stage of an outwards goods shed from a 3-inch "p.p." to a gigantic furniture van, or from the "wings" and "flies" of a theatrical company 30 or 40 ft. long to a tiny box of spring flowers requiring the most careful handling, and which Jack Porter, who is a bit of a wag, is apt to speak of as a "bloomin' noosance."[12]

This success was enjoyed throughout King's Cross Goods Yard, the gross total of goods of all kinds in and out, *exclusive* of coal, approaching one million tons in 1900.[13] Perhaps as a result of this massive stream of goods traffic, and possibly because of wartime demand,[14] the Western Goods Shed was extended *c.*1915 by the construction of an adjoining range of north-lit sheds. It continued to serve outwards goods traffic - and the Granary and transit sheds the inwards traffic - until 1938, when their respective roles were reversed.[15]

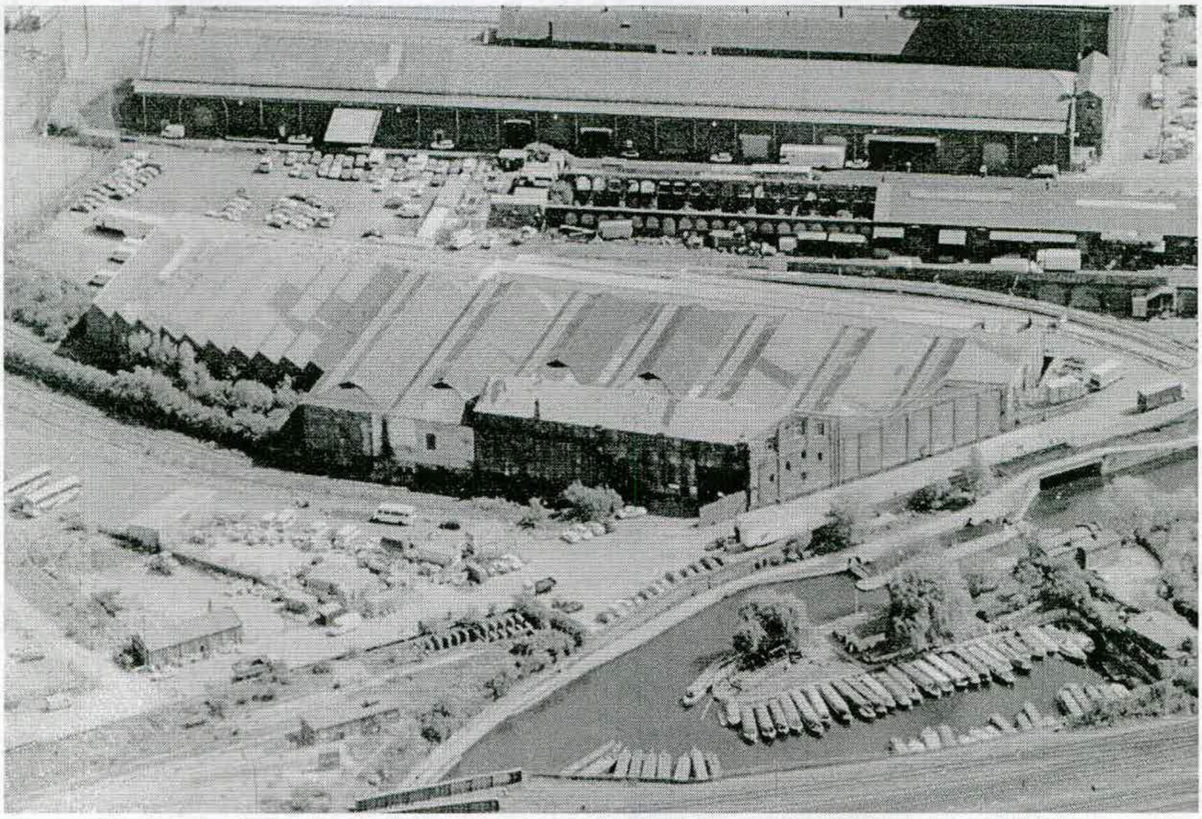


Fig. 1 - Western Goods Shed, aerial view from the west in 1997 (reproduced by permission of NFC).

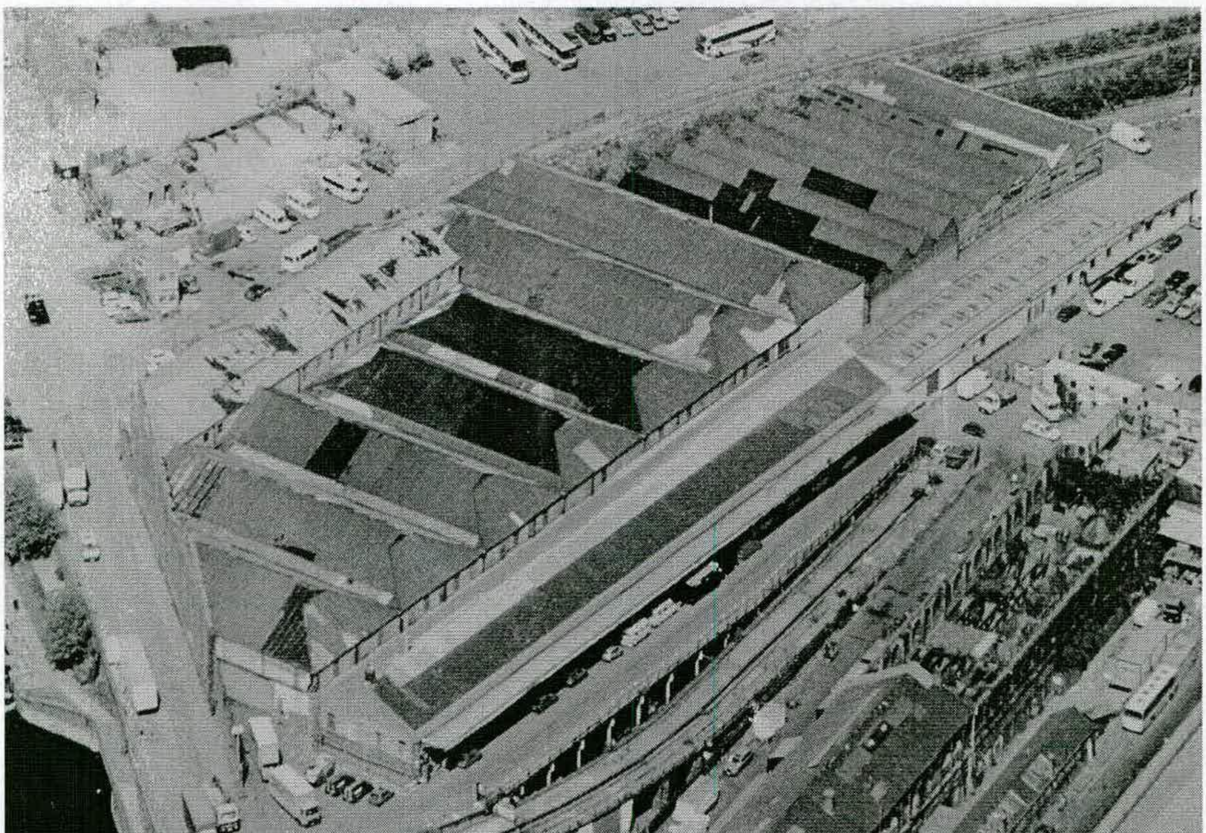


Fig. 2 - Western Goods Shed, aerial view from the southeast in 1997 (reproduced by permission of NFC).

THE WESTERN GOODS SHED

The Western Goods Shed is a low-slung, double-storey building in which brick load-bearing walls, strengthened by piers, were used essentially as a shell to house and partially support an internal frame composed of steel and iron (Figs 1 and 2). As such, it does not represent a true steel (skeleton) frame, a construction system that was finding gradual acceptance in America in the early 1890s[16] and that reputedly found its first application in Britain in 1896 in the form of Basil Scott's furniture warehouse in West Hartlepool,[17] but, like the Deansgate warehouse, and, closer to home, the five-storey G.C.R. goods warehouse at Marylebone (1899),[18] both of which relied upon solid load-bearing outer walls, it nevertheless demonstrates faith in substituting rolled-steel beams *and* stanchions for the then near-habitual wrought-iron beams and cast-iron columns. Despite the pioneering use of this material in 'proto-steel-framed' buildings such as these, the fact that as early as 1887 Dorman Long published the first section book for steel construction in Britain[19] is indicative of the time lag between production and acceptance.[20]

The irregular plan form of the building - essentially a rectangle bereft of a southwest corner, extended northwards *c.*1915 by timber-clad north-lit sheds - was largely dictated by the shape of the former coal and stone basin which it replaced. This basin, some 3,400 sq. yards[21] (2,842 sq. metres) in extent, orientated NNE/SSW and

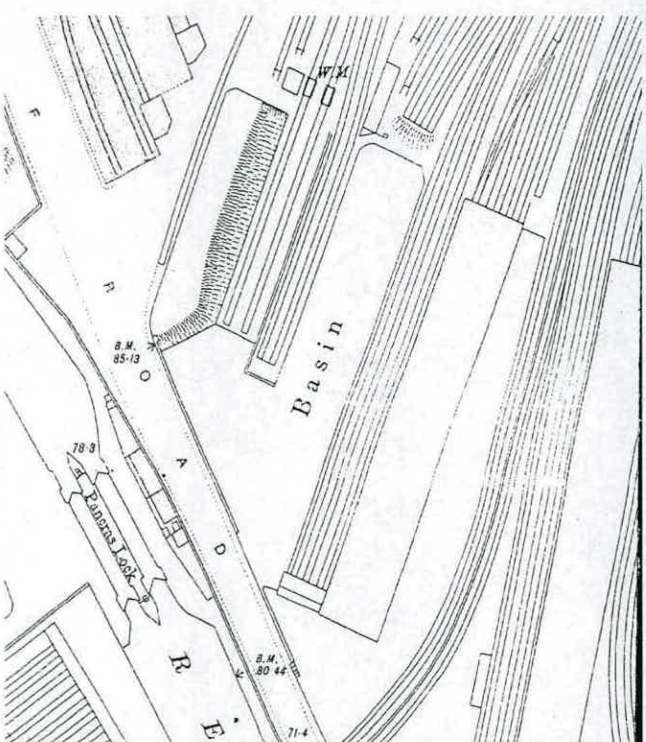


Fig. 3 - Site of the Western Goods Shed, the coal and stone basin in 1894 (Ordnance Survey map).

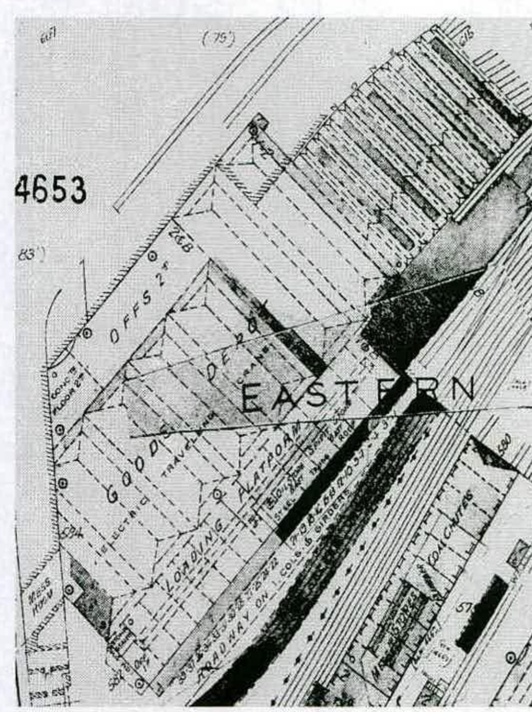


Fig. 4 - Western Good Shed as depicted on Goad's fire insurance map of 1942 (resurveyed from 1891 original).

truncated at the southwest by Wharf Road (Fig. 3), was infilled to provide a suitable foundation level, but it seems clear that the uppermost levels of some of the original brick retaining walls were retained and built against. Certainly the plan form of the lower-level shed closely corresponds to much of the earlier structure, right down to the curved northeastern corner which matches that of the former eastern 'arm' of the basin.[22] The south side of the lower shed still displays the brick oversailing cornice of the basin retaining wall which has been intermittently truncated by the insertion of window openings and water (possibly hydraulic) pipes, and concealed by the brick terminal piers. An earlier cast-iron bridge that spanned the existing inlet connecting Regent's Canal and the basin was left within this retaining wall, presumably because it lent - or at least did not jeopardize - structural support. This is shown on the Goad fire insurance plan of 1942 as a Mess Room (Fig. 4). The stone quoins of the eastern end of this bridge remain visible, engulfed by new brickwork. Ross also brought the former Western Coal Drops into warehouse service,[23] which necessitated the removal and re-erection of the iron rail viaduct running along its west side, to enable laying of the new tracks and loading platform in the low-level shed. The viaduct was re-erected on the eastern side as an inclined roadway serving the first floor, incorporating new steel members to strengthen it, and Dorman Long steel-trough flooring surfaced with cement, coke-breeze concrete, and asphalt.[24]

The Goods Shed in Operation

The primary function of goods stations was "the acceptance, collection and forwarding of outwards traffic and the unloading and delivery of inwards traffic".[25] The manual work was undertaken by gangs of loaders and porters, operating under the supervision of checkers and shunters who "placed" the wagons as required by the goods foreman. Sheeters, Number Takers and Labellers worked alongside these Porterage and Traffic Staff within a strict line-management system under overall control of an Inspector or Chief Foreman. On the accounts side, Invoice Clerks, Delivery Clerks, Claims Clerks, Cartage Clerks, and Canvassers kept a largely separate routine, under overall supervision of a Chief Clerk.[26]

The basic layout of the Western Goods Shed comprised, on both levels, a series of raised loading banks or platforms with longitudinal rail tracks running along the centre, between the tracks. Cartroads, ranged around the perimeter of the building (and in the low level, the centre) communicated with the other faces of the banks, enabling transferral of goods on the level from carts or drays on one side, and railway waggons on the other. The edges of the cartroads on both levels were protected by cast-iron kerbstones manufactured by W. Richards and Son of Leicester. Loading and unloading was performed with barrows or trolleys, and for heavier articles, platform-mounted pillar cranes with sufficient radius to reach both sides of the bank. The banks, timber framed and surfaced with heavy planks, were necessarily wide to enable the sorting and stacking of consignments awaiting onward transport[27](Fig. 5). Similarly, the cart roads were of sufficient width to permit the circulation of drays in both directions.[28] Hydraulic Power was extensively used for shunting capstans, cranes, and a goods lift which connected the two floors. Such was the

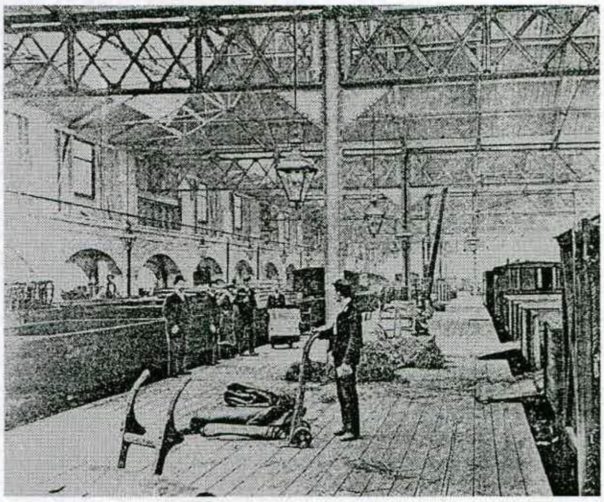


Fig. 5 - High-level goods shed, interior view as it was in 1899, looking south. The converted Western Coal Drops are visible on the left hand side. (From Transport: the Weekly Railway Review*).*

anticipated demand for hydraulic power that the existing hydraulic power station in the Goods Yard was significantly enlarged at the time of the shed's construction.[29] An overhead travelling crane was installed above part of the eastern platform of the high level shed, probably in the early twentieth-century, presumably to enable the manoeuvre of extraordinarily heavy items.

Despite the key operational and organisational similarities between the two levels, some important differences are discernible that reflect both functional and structural considerations. It seems likely that the low-level goods shed and the lower floor of the converted western coal drops provided warehousing facilities besides basic interchanging of goods from road to rail. Regarding the ground floor of the coal drops building, the retainment of the original bay or cell cross walls, albeit with inserted arched openings, would have lent itself more to compartmentalised storage and less to easy communication between the cart road to the east and bank to the west. Similarly, the double doors, ventilation holes and timber shutters built into each arched bay of the front (eastern) elevation of that building are redolent of warehouse architecture. In the low-level goods shed, the employment of non-combustible stretches of flooring - essentially structural in purpose -, coupled with a surfeit of floor space parallel to the south wall may relate to goods storage besides general goods handling. More generally, the layout of the low-level shed, as depicted in Fig. 7, is less efficient *vis-à-vis* swift interchanging for outwards loading compared to the high level. Turntables were used to connect the eastern two tracks with the three entering from the cutting via transverse tracks - a source of delay in the inwards 'forming up' of empty waggons and the outwards movement of loaded waggons. Also, the banks were isolated from one another, preventing the direct trucking of traffic from platform to platform, which otherwise had to be performed with up and down ramps. The high-level shed represented an advancement on both these counts: multiple tracks, each served by platforms connected behind the rail dead-ends, obviated the need for turntables, which in turn facilitated capstan shunting. Stored goods were presumably transported from low to high level via the hydraulic lift.

The Exterior

In keeping with the other buildings on the site, notably the Granary, the Western Goods Shed was executed in a sparing classical style with little or no attempt at superfluous ornament. J. Medcalf remarked in 1900: "In appearance it is prosaic enough - you can't go into ecstacies [sic] over the beauty of its situation, or the classic lines of its architecture".[30] Only the southern and western elevations provided scope for architectural expression, since the north end was open for the movement of waggons, and the east side was already substantially formed by the former Western Coal Drops. Both these elevations are built in yellow (English bond) London stock bricks, rising from a plinth of Staffordshire blues. The south elevation, which is best viewed from across the canal (Fig. 6), rises to two flattened triangular parapets that suggest a large, double-hipped roof behind, but in fact conceal seven gabled roofs orientated east-west spanning the goods shed, and an

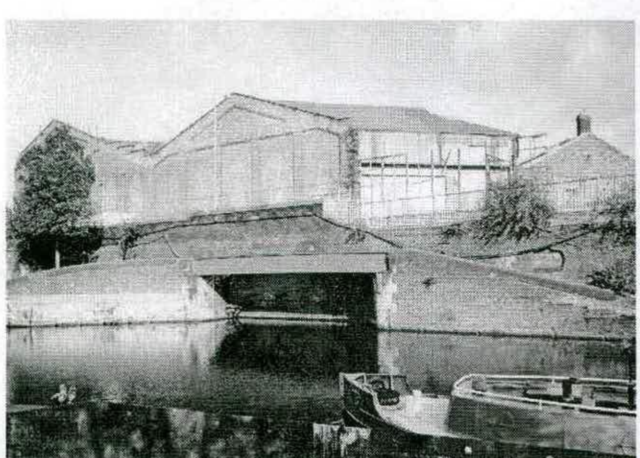


Fig. 6 - Western Goods Shed, south elevation as seen from the Regent's Canal (RCHME, BB98/26496).

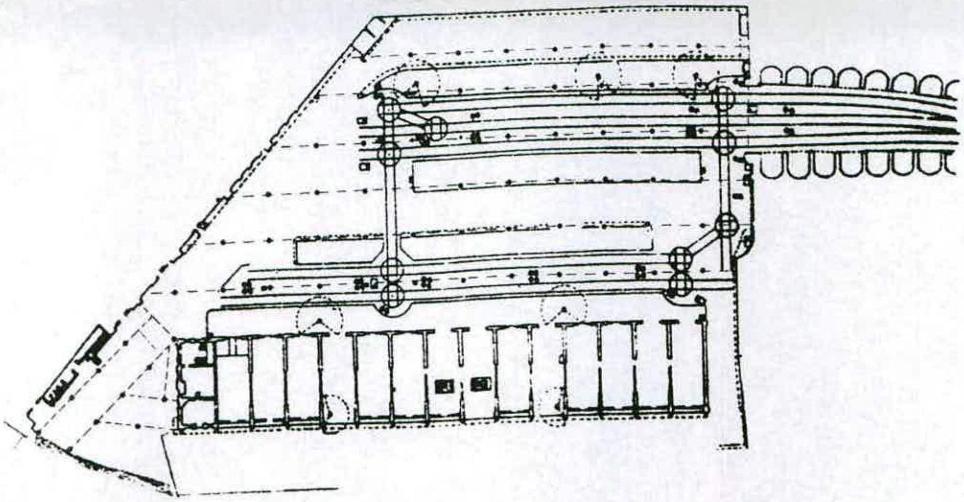
adjoining hipped roof (orientated north-south) to the west over the offices. Tall segmental-headed and semicircular-headed windows punctuate this elevation (now mostly blocked), with piers, and stepped oversailing courses in either tympanum providing restrained embellishment. Originally the parapet was painted with the words "GREAT NORTHERN RAILWAY GOODS DEPOT KINGS CROSS".[31]

This admixture of features and fenestration is reiterated on the west elevation, which for the great majority of its length has three storeys because of the upper-level offices, dropping to two to the north. The three-storey block is divided into eight bays by narrow piers that originally terminated in chimney stacks serving the offices, but which now, with one exception, are truncated at eaves level. Pairs of tall semi-circular-headed windows set in the intermediate bays pierce the lower storey, formerly illuminating the cart road of the high-level goods shed, whilst rectangular windows in corresponding positions lit the offices above. The adjoining two-storey elevation is relieved simply by two large segmental-headed windows set in recessed panels,[32] which also lit the cart road. Linked to the north of this, and set back, is the blank, wholly utilitarian brick elevation of the *c.*1915 extension, notable only for the characteristic saw-tooth profile of the glazed timber roof that rises above the vegetation. The entrance to the north, and the east elevation of the extension, were for the most part open, clad above head-height with parallel-faced weatherboards nailed to timber panel-frames that span between steel stanchions. The four southern bays are executed entirely in brick, however, and are further distinguished by the incorporation of down-pipes. Corrugated-iron sheeting now seals the open bays.

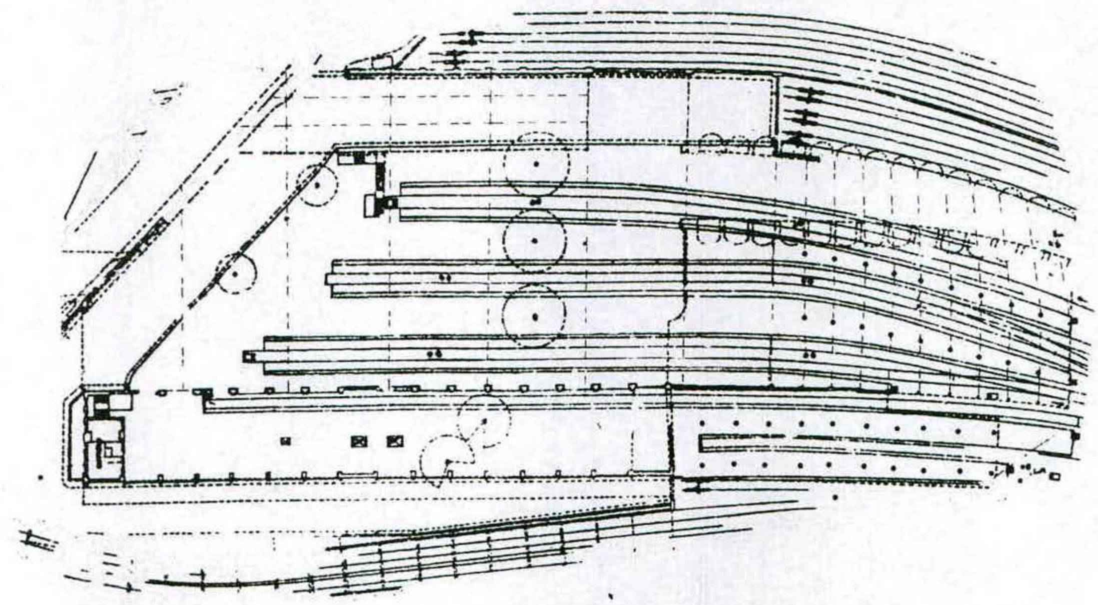
The Low-level Goods Shed: Internal Structure

Occupying an area of some 5,600 sq. yards (4,690 sq. metres), exclusive of the former Western Coal Drops, the low-level goods shed exhibits a rational concern for accommodating the intended processes - essentially the loading of goods from road to rail on one level, both in the scale of the layout and in structural design (Fig. 7). The internal frame, divided into twelve transverse bays (orientated WWN/EES) and seven longitudinal bays by cast-iron columns spaced on 27ft 6in.(8.38m) longitudinal centres and 25ft 9in. (7.85m) transverse centres, is contained within thick load-bearing walls formed from English-bond blue Staffordshire brick set in cement. Resting on the column caps are massive steel-plate girders running longitudinally (NNE/SSW) which support transverse compound rolled-steel joists from which mass-concrete jack arches spring. Some areas of the upper-floor structure are devoid of steel joists, where steel-trough flooring and timber boarding are substituted for concrete jack arching (see below). Terminal brick piers on the north and south walls support the ends of the plate girders, and in the latter wall, which is angled roughly 45 degrees to the building's axis, smaller brick piers are also incorporated for the support of the compound rolled-steel joists. On this wall the larger piers are 5ft (1.52m) in width and 32in. (81.5cm) in depth; the smaller piers measure 32in. (81.5cm) by 11in. (28cm). On the western wall the compound beams rest on stone templates, whilst on the eastern, or former Western Coal Drops wall, inserted bressumer beams span the openings, and brick piers lend support.

The three forms of flooring carried by the iron and steel frame are basically arranged in a series of alternating longitudinal bands that principally relate to the nature of the floor-loading in the high-level goods shed, but may in part reflect later alterations. This flooring does not wholly respect the longitudinal bays as defined by the steel-plate girders, variously over- or under-sailing these, since it is essentially dictated by the lines of the three pairs of tracks above. Concrete jack arching is employed in four strips within (from the west) the first and second, fourth, fifth and sixth longitudinal bays. That in the first and second, and sixth bays respects the longitudinal bays and relates to the additional loading



The low-level goods shed



The high-level goods shed

Fig. 7 - Internal organisation and structure of the Western Goods Shed, based on 1930s G.N.R. map of King's Cross Goods Yard (Railtrack Archives, York). The principal girders (dashed lines) have been added.

The (narrower) strips of jack arching within the other bays support the central and western pairs of tracks. Top-lights set in alternate jack arches pierce the three eastern concrete bands, formerly throwing 'borrowed' light from the upper shed to the interior of the lower level.

Set among the three western concrete bands are two narrow strips of Dorman Long steel-trough flooring that seem to correspond to the loading platforms above.[33] The floor structure between the two eastern concrete bands comprises timber trusses of Warren configuration resting on the compound floor of the

Fig. 8 .- Low-level goods shed, interior showing timber trusses supporting the platforms above (RCHME, BB98/26509)

concrete bands comprises timber trusses of Warren configuration resting on the compound floor of the platform above (Fig. 8). The steel-trough flooring seems to conceal trusses supporting the other platforms, and may have been a later insertion as a fire-resistant measure. Support for this interpretation comes from the high-level station where the sides of the platform are clad with thin corrugated-iron sheeting, permitting glimpses of trough flooring cladding the underside of the trusses. Originally the sides of the platforms may have been open to throw some additional 'borrowed' light through the trusses and into the interior of the low level. In the southern portion of the shed there are isolated, narrow runs of concrete jack arching and adjacent plank flooring. Given the questionable functional utility of the former, it seems likely that in these cases at least the jack arching has been cut away, exposing the timber floor above.

Rail Access to the Low-level Goods Shed

The low-level shed had direct connection with the main rails of the goods yard via three railway lines that entered the goods shed from the north through a curved cutting. This cutting is buttressed on either side by substantial, deeply pocketed retaining walls constructed from blue engineering brick in English bond. In elevation, segmental-arched heads formed from four courses of headers spring from 32½in. (83cm) wide piers. In plan the pockets have straight sides with semi-elliptical back walls; those on the east side are (approximately) a metre deeper, possibly because of the additional support required to accommodate the inward turn of the higher level tracks on this side. Above the pockets, bevelled stone coping set a couple of feet above the arched heads survives in the northerly section of the cutting.

In *c.*1915 the cutting was roofed over to enable the construction of the north-lit sheds on the upper level. Contract drawings show that this floor structure is for the most part made up of deep-section plate girders that rest on the opposing brick piers that in turn support a concrete floor reinforced with closely spaced (old) rails arranged longitudinally. Two old rolled-steel joists rather than plate girders were reused between two of the piers.[34] Most of this structure remains concealed above steel-trough flooring which hangs from the lower flanges of the plate girders in the southern section (Fig. 9). The southernmost portion of the cutting - corresponding to the southern three pockets - was however presumably always roofed over because sited above this is the north (end) bay of the High Level Goods Shed. Possible survivals from this original floor may be an extremely deep plate girder spanning the end piers forming the entrance to the shed, and a smaller section compound beam immediately flanking it to the north. This plate girder must certainly date from 1897-9, since it supports a longitudinal plate girder of the goods shed. Apart from these two members, those girders

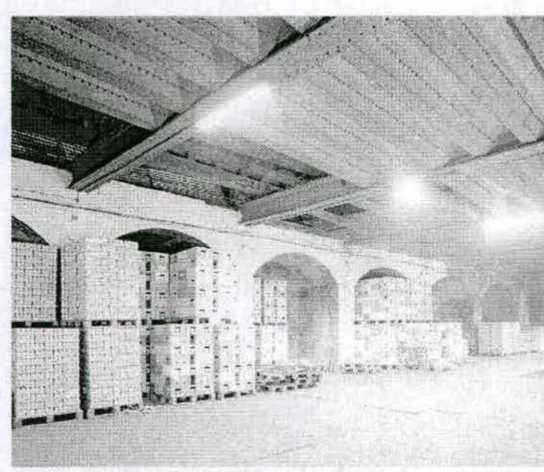


Fig. 9 - Low-level goods shed, rail access roofed-over in c.*1915 with steel-trough flooring (RCHME, BB98/26506).*

further north are commensurate with those depicted in the 1915 drawings, suggesting that the original floor was replaced at this date.

Subsequent alterations, including a possible raising of the floor structure, appear to have been carried out. In the northern and central section, on the western side only, brick walls, approximately 3ft (1m) high, have been built up from the upper flange plate girders. These support a floor of rolled-steel joists with (presumably reinforced) concrete set flush with their lower flanges. Late-twentieth-century alterations include the concreting over of the rail tracks for road vehicle use and the creation of a cold storage area with a suspended ceiling in the northernmost section.

The High-level Goods Shed: Internal Structure

Although virtually duplicating the functions of the low-level shed, the high-level goods shed nevertheless exhibits minor structural and organisational differences that relate in part to the greater freedom inherent in designing a roof-supporting floor unrestricted by a pre-existing 'footprint'. In terms of the latter, the upper-level shed extended one bay further to the north, and, given that costly cuttings did not have to be built, three separate pairs of tracks entered the shed obviating the need for the cumbersome turntables of the lower level (Fig. 7). The employment of steel stanchions and girders to support the (relatively) light roof trusses enabled the requisite clear floor space for generous track provision. Because of this, the high-level shed was, from a general goods handling perspective, functionally more important - having a truck capacity of 90 waggons compared with the lower level's 60.[35]

The high-level goods shed is divided into seven transverse bays by deep lattice girders, resting on widely spaced compound steel stanchions, which support composite roof trusses. The steelwork for this level was provided by Dorman Long and the Phoenix Foundry Company of Derby. Below floor level, the stanchions are seated on stone templates which in turn rest on the longitudinal steel-plate girders of the lower level. The transverse lattice girders they support extend between the stanchion caps, their soffits resting on opposed triangular plates rivetted to the stanchion flanges at a height of 19ft (4.86m) above platform level.

On the east side, the lattice girders rest on stone templates (padstones) inserted in the west wall of the former western coal drops, or on steel beams (supported underneath by stiffened plate girder sections) spanning the piers. Because the pier spacing of this wall does not match the longitudinal spacing of the stanchions, the lattice girders rarely terminate neatly on the piers or the midpoint of the steel beams. On the third bay from the south, the transverse girder rests on an I-section rolled-steel joist spanning the open space between two piers where the arch and panel have been removed, presumably in the interests of facilitating intercommunication between the two buildings through increased headroom. Despite the general lack of beam/pier correspondence, the piers have nevertheless been strengthened by 'wrap around' brickwork since they still bear the increased loading, albeit less directly. In the north bay, which extends beyond the former coal drops, the northernmost transverse girder rests on a large pier marking the northeast corner of the shed. This bay was originally open to the east, a lattice girder of similar form spanning longitudinally that pier and the angle buttress of the former coal drops. A similar arrangement is employed in the road entrance at the south - a lattice girder spans the end wall of the former coal drops and the obliquely angled south wall of the goods shed.

On the west side, only the two lattice girders defining the northern bay extend fully to the piers of the

west wall. To the south of this, the lattice girders terminate at a longitudinal steel-plate girder resting on sturdier stanchions of different form arranged longitudinally, parallel to the west wall (see *steel stanchions*, below). The west side of this girder supports transverse steel-plate girders, whose other ends rest on stone templates embedded in the piers of the west wall of the shed. Three rows of rolled-steel joists, resting on angles rivetted to the web of the transverse girders, extend longitudinally throughout this area and support a plank floor of the offices above. The southern extent of this floor structure, immediately east of the west road entrance, is sturdier still: closely spaced rolled-steel joist
s support a flat (presumably reinforced) concrete floor. This may relate to additional floor loading in this area with the offices above (a metal strongroom or safe), or possibly to a greater fire risk in the entrance area.

Roof Structure

The lattice girders support seven roof bays, each having ten composite timber and metal trusses, and the gantry of the *Overhead Travelling Crane* (see below). The trusses are of a hybridised queen-post form, in that wrought-iron rods are employed for the queen-post and the tie beam, and, given the width of the span, intermediate metal posts and struts are used between the 'queen rods' and the heels of the truss. To support the ridge, a timber king-post slings up the timber collar beam to the apex, where a cast-iron socket receives the principal rafters. Cast-iron sockets are used to connect the principal rafters (which are formed from two lengths of timber with their ends butting), the collar beam and the wrought-iron 'queen rods'. The tie rods are forged with eyes to enable connection with the struts (tee-section wrought iron or possibly steel) and the upright rods, which pass through them both. The outermost portions of the tie rods, between the upright nearest each wall and the truss feet, is formed by pairs of flats, to permit connection to the shoes. The feet of the trusses are both connected and supported by cast-iron shoes, formed with two jambs or cheeks which grip the principals and flats by means of a pin or bolt. The shoes are cast with a flat bed which is bolted to the upper flange of the lattice girders. At the hipped ends of the spans, circular wrought-iron plates are used to grip the commensurately greater number of intersecting tie rods and tee-section struts.

Fig. 10 - High-level goods shed, interior of the second bay from the south, looking south (RCHME, BB98/26521).

Perhaps because the spans of the five southern roof bays are slightly wider than those of the two to the north, those trusses incorporate more intermediate metal posts and struts between the 'queen rods' and the heels of the truss. They employ a total of four diagonal struts, and six tie-rods, compared to, respectively, two and four used in the two northern bays. The structural members are however of uniform type throughout the building. These minor differences are not necessarily indicative of phasing (see note 42), since the two northern bays may have been built narrower because of some (unknown) spatial precondition that dictated the original northern extent of the high-level shed.

The roof covering comprises corrugated iron laid upon boarding; the latter being employed to prevent condensed water dripping onto the floor. The north side of each roof incorporates a glazed strip extending between three side purlins and running the entire length.[36]

Offices

Although substantially modernised through the insertion of modern partitions and suspended ceilings (which conceal the original layout), the offices retain their double-hung sash windows, composite roof trusses, and boarded internal cladding. These trusses appear to be simply a 'scaled-down' version of those employed in the two northern bays. The offices were reached principally by an electric elevator that communicated with the cart road below, and a flight of iron stairs affixed to the west elevation. They were also accessible from the interior of the high-level goods shed via a separate flight of wooden stairs. Sited in the second bay from the south, these lead up, via a dogleg and landing, to a small extension of the office area supported on cantilever steel brackets attached to the longitudinal plate girder. This timber-framed structure, also boarded, and incorporating windows enabling sight of much of the goods shed, presumably functioned as a surpervision point for the Goods Manager or Chief Foreman.

Fig. 11 - High-level goods shed, supervisor's look-out point and access stairs (RCHME, MF99/00412/3).

To the south, in the re-entrant formed by the south elevation and the offices, is a similar structure also supported by cantilever brackets connected to the same girder. Reached only by a set of stairs attached to the south elevation, its function is unclear. Although provided with two windows, hinged on the bottom rail, these are of insufficient size and set at inadequate height to have served supervision. The interior of this angular space is entirely barren of any features indicative of original function. A recent sketch plan compiled for the building's fire officer labels it as a store,[37] which may conceivably have been the case originally.

*c.*1915 Extension to the North

In *c.*1915 the high-level goods shed was extended approximately 160ft (50m) northwards, presumably to enable longer trains of waggons to be loaded up under cover. The makeshift form of this - timber-framed north-lit trusses carried on slender steel stanchions - was almost certainly for reasons of economy, but was really all that was required to screen-off the weather.[38] The shed was originally open on its northern end and along the northern portion of the eastern side, where the three tracks entered (Fig. 12).

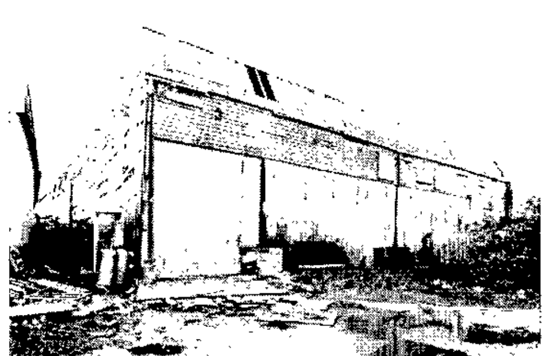


Fig. 12 - North-lit extension of c.1915, view from the north (RCHME, BB98/26495).

Three ranks of slender, upright, I-section rolled-steel joists with heavier section rolled-steel joists extending across their heads divide the extension into ten transverse bays. The stanchions, like the external side cladding, follow a gently curving trajectory since their alignment was dictated by the pre-existing track arrangement. The stanchions forming the western rank are seated on the deep-section plate girders spanning the cutting below, those comprising the other two ranks presumably rest on templates set in the ground below the platforms. At their ends, the beams rest on shallow brick piers, apart from the open east side, where they rest on stanchions of identical form to the others. The beams support the valleys of the timber roof trusses, which are of simple collar-rafter construction, glazed on the north side.

The northwest part of the shed is separated off with timber-framed partitions. At the south end a large door hung on 48in. Redman's strap hinges, reused from the former Western Coal Drops,[39] provides entrance. The original function of this space is unclear, but could relate to storage of the workers' belongings.

The construction of this shed may have been accompanied by the construction of a long, narrow shed flanking it to the east and adjoined to the north elevation of the former Western Coal Drops. Externally, only the lower brick courses of the latter building survive, the rest having been replaced in modern brickwork, but Figure 7 shows that ten pairs of stanchions arranged in two ranks provided internal support. Its function is unclear, but may have comprised warehousing for the *c.*1915 extension.

Operational Fittings

Physically, much of the evidence documenting operational processes has been removed or concealed in the course of the building's conversion to modern warehousing and light industrial use, Figure 7 providing the most complete source for reconstructing them. The tracks have mostly been removed or concealed underneath tarmac, with concrete or heavy planking laid between the banks. The banks too have variously been removed or rearranged, and the granite-set cart-roads survive in isolated patches. Faint traces of painted numbers on the west wall of the high-level document former road vehicle loading bays, while similar evidence on the exterior of the *c.*1915 extension demarcate loading banks for the locomotive drivers. Two neighbouring signs warned drivers reversing trains of waggons into the shed that "ENGINES MUST NOT PASS THIS BOARD"- locomotive engines were never allowed inside the buildings for fear of engine sparks.[40] Nearly all hydraulically powered and hand operated machinery - capstans, turntables, cranes, and lift, has been removed, only one capstan surviving inside the *c.*1915 shed with emplacement evidence for another remaining immediately north of this. What may be a hydraulic supply pipe, boxed in for protection, survives *in situ* in the low-level shed. In the low level shed, porcelain fittings, presumably for electrical or telephone cables, remain attached so the underside of some of the rolled steel joists. One trolley survives inside the *c.*1915 extension, whilst another stands some distance outside the building. The cast-iron G.N.R. portable weighing machine spotted in an earlier investigation was not located.[41]

Adequate lighting was clearly important for goods-handling work. Natural illumination was provided by the fenestrated elevations, exterior wall basement lights, top-lighting set between the railtracks of the high level shed, and glazed portions of the gabled roofs. Artificial lighting was used; a contemporary photograph of the interior of the high-level shed shows gas lanterns above the loading banks, suspended from the roof trusses[42] (Fig. 5). The gas lanterns and fittings have however been entirely lost.

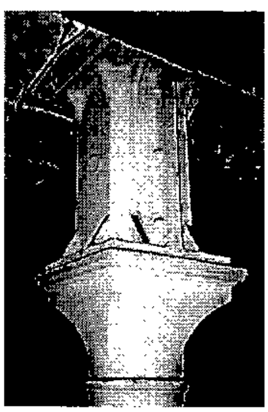
The other aspect of goods shed operation - accounts work - was performed by the clerical staff who worked in the offices. These were presumably lit also by gas lanterns.

TECHNICAL DETAILS

THE LOW-LEVEL GOODS SHED: INTERNAL STRUCTURE

Columns

The columns are classical in form, with a square moulded abacus, cavetto-like echinus, and bead, and rest on separate base castings used to spread the load over a larger area of bed stone. Both the form of the echinus and the radial 'feathers' in the base casting show a concern to accommodate bending strains in the metal at these points. Protective cast-iron caps originally covered the base castings from waggons etc., but these have mostly been dislodged and lost. Faint, linear projections running the entire height indicate that each column - complete with capital - was cast in two halves, complete with oval makers' mark 'W. Richards and Son. Makers. Leicester'. The great majority of columns are 13ft 4in. (4.05m) tall and taper somewhat from 19 in. (49cm) at their base to 17in. (44cm) below the bead. However, the western two ranks of columns, parallel to the west wall, are 3ft (91.4cm) shorter and have a more slender (16½in., 42cm) straight shaft. Separate box castings by the same company, reinforced with feathers and assembled from two halves bolted together, make up the necessary three feet between steel-plate girder and column cap. The function of these is unclear: they might relate to a possible 'bodge' on the part of the contractor in ordering the correct amount of larger ones, or to an economising measure by the G.N.R. to utilise existing stock.[43] Alternatively they may be a deliberate structural feature: this area of the building supported the offices on the second floor in addition to a roadway on the upper level and the castings may have served to distribute and absorb heavier loads, both dead and live. Certainly the situation of one of these columns - immediately flanked north and south by stanchions of similar form to the more numerous type in the floor above (see *Steel Stanchions*) to lend further support to the plate girder - lends credence to the last notion.



RCHME, MF99/00411/4

The employment of cast-iron columns as opposed to steel stanchions on the lower level ostensibly betrays an uneasiness in entrusting the new material to severe compressive loading, but, may also represent a prudent decision based on the relative behavioural properties of the two metals under specific conditions. Ross was certainly aware of the liability of cast-iron columns to cracks, flaws and unevenness in cylindrical section, for in his specification for the adaptation of the coal drops, he stipulated that small holes must be drilled at intervals to check the latter.[44] He was probably also aware that the ultimate compressive strength of cast-iron was known, whereas that for mild steel (and wrought-iron) could not be accurately measured on account of their ductility. Certainly the *safe* compressive resistance of cast iron tabulated in one publication a decade later shows it to be superior to mild steel at this comparatively early date.[45] Further, cast iron could be used advantageously when the columns were not carried up over one floor, and where there was a potential fire risk: when unprotected from fire, cast iron, although liable to crack, was likely to support its load, whereas a steel stanchion would probably entirely fail under equivalent conditions.[46]

Plate Girders

Formed from plates built to an I section, with angles rivetted to the web and flange junctions, these primary members are necessarily huge to resist the severe tensional, compressional and shear stresses acting upon them. Accordingly they have a web-flange dimension of 30in. (76.2cm) by 24in. (60.9 cm) . Pairs of closely spaced angles with deep stems provide additional strength against buckling of the web. The lower flange is made up of multiple layers of plate which increase in number towards the centre of the span, where the stresses are greater. The plates are chain rivetted together close to the edges of the flange, and staggered rivetting along the central axis connects them to the angles.

Rolled-Steel Joists and Concrete Jack Arches

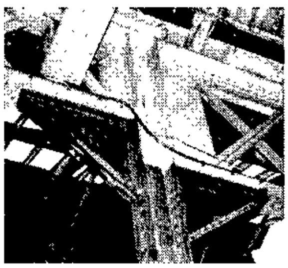
Spanning the lower flanges of the rolled-steel joists are deeply coved solid concrete arches, five to each bay. Each has a span of 4½ft (1.38m) and a rise of 17in. (43cm). The joists, marked Dorman Long on the web (those supporting the platform trusses are not concealed) are formed from simple deep-web rolled steel joists with plates rivetted (staggered) to the upper and lower flanges to increase their width [12in. (30.5cm)] and flange depth [¾in. (1.9cm)] Like the plate girders, more than one layer of plate is employed, but in this case only two at the centre portion. The joists do not seem to rest directly on the lower flanges of the girders: there is a gap of a few inches between the two members. Those supporting

RCHME, BB98/26508

the platform trusses show that their ends are bolted to the web of the plate girders by means of angles, but presumably metal stools or packing pieces are used also, given the likelihood of shearing at these points.

THE HIGH-LEVEL GOODS SHED - INTERNAL STRUCTURE

Steel Stanchions


RCHME, MF99/00412/29

The stanchions used throughout the high-level goods shed are of two forms. The more numerous compound form is fabricated from deep-web I-sections with ⅝in. (2cm) thick plates chain rivetted to their outer flanges to give a resulting web-flange dimension of 13½in. (34cm) by 12in. (30.5cm). Those defining the southern five bays are spaced transversely on 37ft (11.28m) centres, and longitudinally on 54ft (16.5m) centres. Those defining the northern two bays are spaced transversely on analogous centres, but on shorter longitudinal centres: 49ft (14.9m.) centres. Brackets rivetted to the upper portion of the flanges support the lattice girders. These are formed from triangular shaped plates with angles rivetted back to back around the sides.

The other type, of which there are four, run parallel to the west elevation. They are formed from deep-web I-sections with two smaller I section rolled-steel joists rivetted centrally to either side of the web of the former. Horizontal ⅞ in. (2.2cm) thick strapping, rivetted to the four flanges, provides stiffening at intervals along the stanchion's height. The resulting equal web-flange dimension of 19in. by 19in. (48cm) presumably imparts greater compressive strength and rigidity, given that these stanchions support the offices on the second floor in addition to the roof trusses. They terminate in rivetted brackets assembled from angles and triangular and square-shaped plates which spread the load along the supported beam's axis.


RCHME, MF99/00411/18

Lattice Girders


RCHME, MF99/00412/14

The lattice girders are of a double Warren form with the addition of vertical struts under the feet of the roof trusses where the loading is concentrated. The great majority have web-flange dimensions of 4ft 4in. (1.32 m) by 18½in (47cm). The flanges are formed from ½in (1.27cm) thick angles and plates and the web members comprise angles, flats and tees which are rivetted to the former via rectangular gusset plates. The verticals are formed from tees placed back to back. Their ends bend outwards to enable their flanges to connect with those of the main member. The vast majority of the lattice girders are of identical form, but two exceptions are evident. That terminating at the east wall, supporting the ends of the two southern roof trusses, has a web depth approximately three-fifths that of the others. The supporting angle bracket is positioned at a correspondingly higher level. The reason for this is unclear, since it seemingly performs the same function as the others, i.e. the loading upon it appears no different. The other exception is those defining the northernmost bay, which are slightly lighter, but of corresponding dimensions and configuration of members. In these the flanges are narrower (the plates covering the angles are the same width as the paired angles) and the web does not incorporate tees. This probably relates to the somewhat lighter trusses they support (see note 28).

Steel-Plate Girders

These appear to be of corresponding web-flange dimensions to the lattice girders, although the top flange and upper portion of the web are concealed by the concrete floor. In form also, the flanges would appear to be built in identical fashion to the lattice girders, although more than one plate is used in the (visible) lower flange, increasing in number towards the centre of the span. The chief difference is the employment of a solid plate web. This is heavily stiffened with vertical tees of identical form to the verticals used in the lattice girder to provide additional strength against buckling. Short lengths of angle rivetted horizontally between the stiffeners support the rolled-steel joists.


RCHME, MF99/00411/17

The longitudinal plate girder appears to be essentially a 'scaled-up' version of the transverse ones. Although supporting the concrete-floored offices, it is of smaller dimensions, the lower (tension) flange at least, than those on the floor below, which support a greater cumulative load.

Steel Stanchions and Beams

Bearing the imprint 'Dorman Long and Co., Middlesbrough' in their webs, both the stanchions and beams are simple rolled-steel joists with no attached stiffening angles or plates apart from at their junction. The stanchions and beams have, respectively, web-flange dimensions of 10in. (25.4cm) by 6 in. (15.2cm) and 18 in. (45.7cm.) by 7in. (17.8cm). The beams are connected to one another over the centre-line of the stanchions by ½in.(1.3cm) thick plates bolted to their webs. Angles of the same thickness, rivetted to the stanchions's flange and bolted to the beams's lower flanges connect the two members. The stanchions are arranged longitudinally on 16 ft. 7in. (5.1m) centres;[47] transversely their spacing varies according to the curvature of the railway tracks.

Overhead Travelling Crane


RCHME, BB98/26515

Only the supporting gantry survives, extending longitudinally northwards from the second bay to the end bay of the 1897-9 high-level shed, where a wood board notifies the former "CRANE LIMIT". The gantry consists of parallel steel-plate girders, of identical configuration but smaller section to the others on this level, which extend between the webs of the lattice girders. Lengths of I-section rolled-steel joists span across the lower flange of the girders and (surviving in the northern bay) bolted to the lower flange of these, parallel to the girders, are inverted channels, which presumably formed the guide rails. Structurally this framework appears coeval with the shed, but a contemporary interior photograph of this area does not show it.[48] The Goad plan of 1942 (Fig. 4) shows the crane was electrically powered.

NOTES

1. This line, which was opened in 1899, transformed the former Manchester Sheffield & Lincolnshire Railway "from a provincial cross-country railway to a trunk route, and justified the then unusual step of giving the company a new name: Great Central." Andrew Dow, "Great Central Railway" in Jack Simmons and Gordon Biddle (eds.), *The Oxford Companion to Railway History* (Oxford, 1997), 188-190.

2. Charles Grinling, *The History of the Great Northern Railway 1845-1902* (London, 1903), 438.

3. Jonathan Clarke, *The Great Northern Railway Company's Warehouse, Central Manchester: A Conservation Report*,13. Report for Masters Course in Industrial Archaeology, The Ironbridge Institute (1993). The exorbitant cost of the Deansgate project was estimated to be equivalent to some £50 million in 1979 (Letter from the Victorian Society to The Secretary of State for the Environment requesting that the G.N.R. Company's Manchester Goods Station be listed, dated 1 March 1979).

4. "The Goods Warehouse, Hunslet Railway", reprinted from *Transport: the Weekly Railway Review*, 7 July 1899. Copy in Public Record Office (hereafter PRO) filed with ZLIB 4/36.

5. Michael Hunter and Robert Thorne, *Change at King's Cross* (London, 1990): "King's Cross Goods Yard" (Chapter Five) by Robert Thorne with Stephen Duckworth and Barry Jones. Thorne *et al* provide the figure of 59 acres, though J. Medcalf, former Outdoor Goods Manager, G.N.R., placed the figure at "something like 80 acres of North London", J. Medcalf, "King's Cross Goods Station", *Railway Magazine* IV, April 1900, 314.

6. "New Goods Terminal Accommodation at King's Cross (G.N.R.).", reprinted from *Transport: the Weekly Railway Review*, 7 July 1899. Copy in PRO filed with ZLIB 4/36.

7. *Minutes of the Proceedings of the Institution of Civil Engineers*, 215,1922-23, Pt. 1, 342; *Who Was Who, 1916-1928*, 908. Ross succeeded Richard Johnson, who retired in December 1896, having served the G.N.R. almost from its formation, and 35 years as Chief Engineer. The Manchester, Sheffield and Lincolnshire Railway alleged (correctly) that Ross left its employ and accepted the Great Northern position without giving proper notice. John Wrottesley, *The Great Northern Railway* III, *Twentieth Century to Grouping* (London,1981), 55. Alexander Ross held his position with the G.N.R. until the autumn of 1911, when he retired and went into private practice as a consulting engineer in Westminster. He became a Member of the Council of The Institution of Civil Engineers in 1903, and served as President during 1915-16.

8. PRO, RAIL 236/532, *New Coal Yard & Goods Depôt, King's Cross. Contract, Specification &* (1897). The surviving specification predominantly relates to the conversion of the former Western Coal Drops to be an extension of the Western Goods Shed, and the re-siting of the approach viaduct from its west side to its east side. Other extant contracts and specifications by Ross are for *Offices in Goods Yard* (1898) (RAIL 236/530) and *New Stables at Blandale Street* (1898) (RAIL 236/996). No contracts, specifications or plans relating to the Western Goods Shed have been located.

9. PRO, ZLIB 4/36, *op.cit.* The majority of the other improvements and additions to the site were also completed by this month, but their opening was delayed by a fire caused by an engine spark on 24 July 1899. Wrottesley, *op.cit.*, 55.

10. The building was described as "a marvel in mild steel" *(The Engineer*, 2 September 1898, 225) and as "one of the finest railway goods depôts in the world" (*Railway News,* 25 June 1898).

11. Although the extant documents do not relate specifically to the Western Goods Shed (see note 8), it is reasonable to deduce that the qualities of materials and craftsmanship specified in that were stipulated also for the new warehouse. The steelwork for example had to be mild Siemens-Martin steel, "obtained from an English Manufacturer", of "first rate quality" and capable of satisfying a detailed battery of tests before adoption. PRO, RAIL 236/532, 23-24.

12. Medcalf, *op.cit.*, 314.

13. *Ibid*, 316.

14. Freight traffic across the entire rail network reached an all-time peak in World War I, annual carryings increasing from 367 million tons in 1913 to an estimated 400 million in the war. Grahame Boyes, "freight traffic", in Simmons and Biddle, *op.cit.*, 169.

15. Stephen Duckworth and Barry Jones, *King's Cross Development Site: An Inventory of Architectural and Industrial Features.* Report for English Heritage, November 1988, 6.

16. "Steel and iron-frame construction in the United States", *The Builder*, 15 October 1892, 295-296.

17. Alyson Cooper, *The Manchester Commercial Textile Warehouse, 1780-1914: A Study of its typology and practical development.* (1991) PhD Thesis, University of Manchester, 155; Edgar Jones, *Industrial Architecture in Britain 1750-1939*, (London, 1985), 175.

18. This depôt, constructed by the Great Central Railway for its London traffic provided 510,000 sq.ft. of space on five stories. "It was steel-framed, filled up with the whole battery of mechanical apparatus then in use, and centrally heated throughout." Jack Simmons, *The Railway in England and Wales 1830-1914*, I: *The System and its Working* (London, 1978), 165.

19. Cooper, *op.cit.*

20. In textile mill construction, traditionally in the vanguard of structural development, floors of reinforced concrete supported by H-section rolled-steel *beams* began to appear in the 1880s, amongst the earliest being Palm Mill, Oldham (designed 1884), and Atlas No.6 Mill, Bolton (1888). [Mike Williams with D. A. Farnie, *Cotton Mills in Greater Manchester* (Preston, 1992), 109.] However, the use of steel beams in combination with rolled-steel *stanchions* in mills seems to lag behind that in railway architecture and warehouses - possibly because of the superior fire-resistant qualities of (unprotected) cast-iron columns (see *Columns*). In 1894 Joseph Nasmith, editor of the *Textile Recorder* observed that "no architect has been bold enough to use in mill construction the built steel columns which have been employed in other forms of constructive work". [Joseph and Frank Nasmith, *Recent Cotton Mill Construction and Engineering*, Manchester (c.1895), 56; as quoted in Edgar Jones, *op.cit.*, 162.] According to Jones, "it seems that conservatism or considerations of cost ruled". [Jones *ibid.*, 63.] He also suggests that the continuity of the traditional (local) architect/(family business/ board of directors) client relationship mitigated against structural experimentation, and the lack of engineering knowledge or the reluctance to employ engineers versed in steelwork construction on the part of architects may also have played a part in this context. Certainly the earliest recorded example of the use of the material in both forms of structural member evident is that of Blakeridge Mills, Batley (1912-13). [Colum Giles and Ian H. Goodall,

Yorkshire Textile Mills: The Buildings of the Yorkshire Textile Industry 1770-1930. London, HMSO (1992), 66-7, 70.] This is relatively late compared to documented steel frames in other building types: commercial buildings in the major cities for example were employing it by the 1900s.

21. PRO, ZLIB 4/36., *op.cit.*

22. Ross stipulated that the contractors "cut into old wall at northeast corner of West basin of canal for length of 15' and 17' deep for new pier at foot of incline and connect up to new work on one side." A similar instruction is given for the existing wall at the northwest corner of the east basin. Although difficult to pinpoint in relation to the fabric in the absence of the accompanying drawings, these instructions do show that those portions of the existing walls not "cut into" were left *in situ*. [PRO, RAIL 236/532, *op.cit.*, 75.]

23. For a description of this building, including the 1897-9 alterations, see Malcolm Tucker, *Notes on the former Western Coal Drops*, (unpublished report dated 11 June 1988), and Duckworth and Jones, *op.cit.*, 12-14.

24. RAIL 236/532, 38-42.

25. John Jenkinson, *Railway Operation: Passenger and Goods Station Management and Working* (London, 1915), 3.

26. *Ibid.*, 4-8.

27. Malcolm Tucker,"goods sheds and warehouses" in Simmons and Biddle, *op.cit.*, 183-184; Gordon Biddle, "Goods Sheds and Warehouses", *Journal of the Canal and Railway Historical Society*, XXXii Pt.4, No.166 (March 1997), 293-299.

28. Jenkinson, *op.cit.*, 10.

29. PRO, ZLIB 4/36., *op.cit.* Four new boilers were erected by Messrs. J. Adamson and Co., of Manchester, presumably at the original (1851) William Armstrong hydraulic engine house between the eastern coal drops and the Granary basin (now demolished). This earlier structure is discussed in Robert Thorne *et al; op.cit.*, 105-108.

30. Medcalf, *op.cit.*, 313.

31. This is shown in the background of a photograph dated 1912, showing a lighter in St. Pancras Lock, and a long, single-storey, hipped-roof shed immediately to the west of the goods shed. [Hunter and Thorne, *op.cit.*, 31.]

32. The differences in fenestration, along with other indicators, are cited as evidence that the two storey section to the south of the north-lit sheds is later than the main goods shed [Duckworth and Jones, *op.cit.*, 6-7.] However, although far from unequivocal, the evidence in support of this section forming part of the first phase is more compelling. First, viewed both externally and internally, the brickwork exhibits no differences in bond, colour, size, coursing, etc., and there are no visible straight or ragged joints, or 'toothing' in. The blue-brick plinth runs right across, incorporating identical basement windows. Second, the low level shed extends northwards as far as the divide between the two bays of the two-storey part: from a structural and planning perspective, it seems nonsensical that the high level shed would have 'stepped back' a bay. Third, the form of stanchions and lattice girders defining the end two bays (i.e. the

two storey part) is identical to those employed in the rest of the shed. The westernmost platform, which is most visible, runs right through, showing no obvious extension. Although the differences in roof truss configuration - apparent in the number of diagonal struts and uprights, not the form of the members - have been cited, this is perhaps explicable in so far that the two end bays are not as wide as the others. Similarly, the differences in fenestration are carried through on the south elevation, where both forms of window are employed.

33. PRO, RAIL 236/532, 38-42.

34. Railtrack Archives, Toft Green, York, G.N.R. Engineers Drawing titled *G.N.R. London Goods Yard Extension of Outwards Good Shed, Drawing No.4*, dated May 1915.

35. PRO, ZLIB 4/36.

36. This glazing was provided by Messrs. W. Edgcumbe Rendle, and Co., of Westminster, who glazed the roof of Citadel Station, Carlisle. [PRO, ZLIB 4/36, *op.cit.*; Ruth Richardson and Robert Thorne, *The Builder Illustrations index 1843-1883,* 432].

37. *Sketch of Barpart House, King's Cross*, January 1990.

38. The conventional goods shed was "usually of the fortress order, and would be capable of withstanding a moderate siege....A large proportion of all the expense is in the building of a shell that appears to be unnecessarily strong for the things it encloses.", whereas "all that is wanted is protection for the workers and goods, etc., inside against the elements, and it seems to me that for this purpose a corrugated-iron structure would generally suffice, and easily lend itself to expansion at a minimum cost". [Fred West, *The Railway Goods Station: A Guide to its Control and Operation* (London, 1912).] Corrugated-iron and timber-clad sheds with multiple-span roofs were constructed in the nineteenth century, especially by smaller companies for cheapness, but the major development in the early twentieth century was the widespread substitution of solid walls with metal-clad light steel frames and long-span roof trusses. After World War II the use of steel Portal frames requiring no intermediate support spread. [Biddle, *loc.cit.*, 294 & 297; Tucker, "goods sheds and warehouses" in Simmons and Biddle, *op.cit.*, 183-4.]

39. Ross stipulated that the doors to the openings of the former western coal drops be hung from "48" Redmans gate hinges". [PRO, RAIL 236/532.]

40. Tucker, *loc.cit.*, 183.

41. Duckworth and Jones, *op.cit.*, 8.

42. PRO, ZLIB 4/36.

43. In this respect, it is interesting to note that in the specification for the conversion of the Western Coal Drops, Ross mentions the removal and re-siting of cast-iron columns. Unfortunately, these cannot be accurately provenanced. [PRO, RAIL 236/532, 42.]

44. *Ibid.*

45. G.A.T. Middleton, *Modern Buildings: Their Planning, Construction and Equipment* Vol. IV (London, 1906), 70. The table gives the ultimate resistance of cast iron and mild steel as 36 and 28 (estimated) psi

respectively. Corresponding figures for safe resistance are, respectively, 7 and 6½ psi.

46. *Ibid*, 95.

47. Railtrack Archives, Toft Green, York. G.N.R. Engineers Drawing titled *G.N.R. London Goods Yard Extension of Outwards Good Shed, Drawing No.4*, dated May 1915.

48. This photograph was taken when the offices were still in the process of erection, so it is entirely plausible that the crane could have been added late 1899, or in the very early years of the twentieth-century. [PRO, ZLIB 4/36., *op.cit.*]

JOB NUMBER 98 01965

DATE TAKEN 23/11/98 PHOTOGRAPHER SB
ADDRESS WESTERN GOODS SHED
WHARF ROAD

ISLINGTON

NEGS TAKEN 38

BB98/26488	EXTERIOR. GENERAL VIEW OF WESTERN GOODS SHED IN THE DISTANT VIEW FROM EAST. TAKEN FROM THE ROOF OF THE GRANARY	B&W
BB98/26489	EXTERIOR. WEST ELEVATION. VIEW FROM NORTH WEST	B&W
BB98/26490	EXTERIOR. WEST ELEVATION	B&W
BB98/26491	EXTERIOR. GENERAL VIEW FROM SOUTH	B&W
BB98/26492	EXTERIOR. GENERAL VIEW FROM SOUTH EAST SHOWING THE LOW LEVEL	B&W
BB98/26493	EXTERIOR. GENERAL VIEW FROM NORTH EAST SHOWING THE 1915 EXTENSION	B&W
BB98/26494	EXTERIOR. 1915 EXTENSION DETAIL SHOWING THE END OF THE PLATFORM. NORTH ELEVATION	B&W
BB98/26495	EXTERIOR. 1915 EXTENSION. NORTH ELEVATION. VIEW FROM NORTH EAST	B&W
BB98/26496	EXTERIOR. GENERAL VIEW FROM SOUTH SIDE GRAND UNION CANAL	B&W
BB98/26497	EXTERIOR. GENERAL VIEW FROM NORTH WEST	B&W
BB98/26498	EXTERIOR. SOUTH END. VIEW FROM WEST	B&W
BB98/26499	EXTERIOR. LOW LEVEL. VIEW FROM SOUTH EAST	B&W
BB98/26500	EXTERIOR. HIGHER LEVEL. EAST ELEVATION. BAY 1 FROM SOUTH (FORMER WESTERN COAL DROPS BUILDING)	B&W
BB98/26501	EXTERIOR. LOW LEVEL. SOUTH END. ENTRANCE TO BRIDGE OVER CANAL	B&W
BB98/26502	EXTERIOR. LOW LEVEL. SOUTH WALL. ENTRANCE TO BRIDGE OVER CANAL DETAIL OF CORNICE	B&W
BB98/26503	INTERIOR. LOW LEVEL. SOUTH END. FORMER BRIDGE OVER CANAL VIEW FROM NORTH	B&W
BB98/26504	INTERIOR. LOW LEVEL. WEST SIDE. VIEW FROM SOUTH	B&W
BB98/26505	INTERIOR. LOW LEVEL. EAST SIDE. VIEW FROM SOUTH	B&W
BB98/26506	INTERIOR. LOW LEVEL. RAILWAY APROACH. NORTH END SHOWING TROUGH FLOORING. VIEW FROM SOUTH EAST	B&W
BB98/26507	INTERIOR. LOW LEVEL. EAST SIDE SHOWING DETAIL OF POSSIBLE HYDRAULIC PIPES AND BOXING	B&W
BB98/26508	INTERIOR. LOW LEVEL. NORTH EAST (CURVED CORNER) & INCLINE OF RETAINING WALLS. VIEW FROM SOUTH WEST	B&W
BB98/26509	INTERIOR. LOW LEVEL. EAST SIDE AT NORTH END SHOWING TIMBER PLATFORM TRUSSES	B&W
BB98/26510	INTERIOR. LOW LEVEL. WEST SHOWING PLATFORM AND COLUMN EXTENSIONS. VIEW FROM NORTH WEST	B&W
BB98/26511	INTERIOR. LOW LEVEL. SOUTH END. VIEW FROM SOUTH EAST UNDER ROAD VIADUCT	B&W
BB98/26512	EXTERIOR. LOW LEVEL. EAST SIDE UNDER ROAD VIADUCT. VIEW FROM SOUTH	B&W

BB98/26513	EXTERIOR. LOW LEVEL. SOUTH END EAST SIDE UNDER ROAD VIADUCT VIEW FROM EAST	B&W
BB98/26514	INTERIOR. HIGH LEVEL. CENTRAL BAY. VIEW FROM EAST	B&W
BB98/26515	INTERIOR. HIGH LEVEL. NORTHERN LIMIT OF OVERHEAD CRANE VIEW FROM SOUTH	B&W
BB98/26516	INTERIOR. HIGH LEVEL. WEST SIDE OF 1915 EXTENSION. NORTH END SHOWING SACK TRUCK	B&W
BB98/26517	INTERIOR. HIGH LEVEL. 1915 EXTENSION. VIEW FROM SOUTH WEST	B&W
BB98/26518	INTERIOR. HIGH LEVEL. WEST SIDE. CART ROAD. VIEW FROM NORTH	B&W
BB98/26519	INTERIOR. HIGH LEVEL. WEST SIDE. CART ROAD. VIEW FROM SOUTH	B&W
BB98/26520	INTERIOR. HIGH LEVEL. OVERHEAD TRAVELING CRANE. VIEW FROM WEST	B&W
BB98/26521	INTERIOR. HIGH LEVEL. CENTRAL BAY. VIEW FROM NORTH WEST	B&W
BB98/26522	EXTERIOR. GENERAL VIEW FROM SOUTH SIDE GRAND UNION CANAL	Colour
BB98/26523	EXTERIOR. GENERAL VIEW FROM SOUTH EAST SHOWING THE LOW LEVEL	Colour
BB98/26524	EXTERIOR. WEST ELEVATION	Colour
BB98/26525	EXTERIOR. GENERAL VIEW OF WESTERN GOODS SHED IN THE DISTANT VIEW FROM EAST. TAKEN FROM THE ROOF OF THE GRANARY	Colour