MARINE "A" ELEVATOR
105 Childs Street
Buffalo
Erie County
New York

HAER No. NY-252

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WRITTEN HISTORICAL AND DESCRIPTIVE DATA
PHOTOGRAPHS

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HISTORIC AMERICAN ENGINEERING RECORD

MARINE "A" ELEVATOR
HAER No. NY-252

Location: 105 Childs St., Buffalo, Erie County, New York

Date: Building permit application filed March 16, 1925; issued April 24, 1925; completed, autumn 1925

Designer: T. D. Budd, James Stewart & Co.; Supervising Engineer, A. E. Baxter Engineering Co.

Builder: James Stewart & Co.

Status: Derelict

Significance: The grain elevators of Buffalo comprise the most outstanding collection of extant grain elevators in the United States, and collectively represent the variety of construction materials, building forms, and technological innovations that revolutionized the handling of grain in this country.

Project Information: The documentation of Buffalo's grain elevators was prepared by the Historic American Engineering Record (HAER), National Park Service, in 1990 and 1991. The project was co-sponsored by the Industrial Heritage Committee, Inc., of Buffalo, Lorraine Pierro, President, with the cooperation of The Pillsbury Company, Mark Norton, Plant Manager, Walter Dutka, Senior Mechanical Engineer, and with the valuable assistance of Henry Baxter, Henry Wollenberg, and Jerry Malloy. The HAER documentation was prepared under the supervision of Robert Kapsch, Chief, HABS/HAER, and Eric DeLony, Chief and Principal Architect, HAER. The project was managed by Robbyn Jackson, Architect, HAER, and the team consisted of: Craig Strong, Supervising Architect; Todd Croteau, Christopher Payne, Patricia Reese, architects; Thomas Leary, Supervising Historian; John Healey, and Elizabeth Sholes, historians. Large-format photography was done by Jet Lowe, HAER photographer.

Historians: Thomas E. Leary, John R. Healey, Elizabeth C. Sholes, 1990-1991

This is one in a series of HAER reports for the Buffalo Grain Elevator Project. HAER No. NY-239, "Buffalo Grain Elevators," contains an overview history of the elevators. The following elevators have separate reports:

NY-240 Great Northern Elevator
NY-241 Standard Elevator
NY-242 Wollenberg Grain & Seed Elevator
NY-243 Concrete-Central Elevator
NY-244 Washburn Crosby Elevator
NY-245 Connecting Terminal Elevator
NY-246 Spencer Kellogg Elevator
NY-247 Cooperative Grange League Federation
NY-248 Electric Elevator
NY-249 American Elevator
NY-250 Perot Elevator
NY-251 Lake & Rail Elevator
NY-252 Marine "A" Elevator
NY-253 Superior Elevator
NY-254 Saskatchewan Cooperative Elevator
NY-256 Urban Elevator
NY-257 H-O Oats Elevator
NY-258 Kreiner Malting Elevator
NY-259 Meyer Malting Elevator
NY-260 Eastern States Elevator

In addition, the Appendix of HAER No. NY-239 contains brief notations on the following elevators:

Buffalo Cereal Elevator
Cloverleaf Milling Co. Elevator
Dakota Elevator
Dellwood Elevator
Great Eastern Elevator
Iron Elevator
John Kam Malting Elevator
Monarch Elevator
Pratt Foods Elevator
Ralston Purina Elevator
Riverside Malting Elevator

The Buffalo-based Abell family was responsible for the building and operation of the Marine elevators. William H. Abell built the original Marine Elevator about 1870 on the site of the recently burned Hatch Elevator of 1848. The new enterprise was located beside the Hatch Slip at its junction with the Buffalo River downstream of the Michigan Street Bridge. Of wooden crib construction, the elevator had a capacity of 150,000 bushels. In 1894, C. Lee Abell added a further 500,000 bushels of storage at the original site. This elevator, equipped with one of Buffalo's first movable marine towers, had a capacity of 500,000 bushels and was also of wooden cribbed construction. Upon completion of the new elevator in 1925, the old elevating complex became known as Marine "B".[1]

In the second decade of this century, Harold L. Abell drew up an ambitious expansion plan. Rather than attempt to construct more capacity at the cramped Hatch Slip site bound by the Great Eastern Elevator and Washburn Crosby complex, he acquired an undeveloped site high up the Buffalo River. The site had a river frontage of 1,145' and was located between the then existing Perot and Dellwood elevators. A 5,000,000 bushel complex was planned which, in addition to fulfilling a transfer function, was also to serve an on-site mill. The 2,000,000-bushel mainhouse was to be flanked to the north by a 1,000,000-bushel annex, and to the south by a 2,000,000-bushel annex, but only the mainhouse was constructed. The north annex would have occupied the vacant land between the mainhouse and the south annex of the Lake & Rail Elevator. The mill was to occupy a site between the southern end of the completed complex and the Dellwood "C" Elevator.

The elevator is Buffalo's only example of bins constructed according to the detailed drawings of T. D. Budd's patent for the "Improvement in Grain Elevators" granted in 1921. The innovations introduced in Marine "A" were to have far reaching effects on elevator design. Within nine years of its introduction to Buffalo, the last major elevator of conventional design, the Perot Annex of 1933, had been built; all subsequent elevator designs were derivatives of the Budd patent. Rather than raising the bins on a full bin slab above basement columns which bore the weight of the structure, Budd's design carried the bin walls down to the foundation slab in a similar fashion to a tunnel type elevator. Within each bin he raised a full width conical hopper on pilasters to provide an adequate basement.

Budd claimed that his design was "easy, cheap, convenient to install, fireproof, rigid and durable", requiring "decreased amounts of material yet "gaining 5% greater storage capacity with no increases in the height of the bin." The design sought to "carry the total load directly to the foundations" instead of carrying the load indirectly through an arrangement providing for cross bending moments and compression, as in the conventional bin slab. His design featured the economy and ease of construction associated with the tunnel type elevator, yet provided a full working basement. Although the bin walls rose directly from the foundation slab, the hoppering arrangements were entirely different from those of the tunnel type elevator. Rather than a conventional concrete slab hopper bottom resting on slag concrete infill and discharging into a sub-basement tunnel, Budd's design featured steel hopper bottoms raised by various means above the foundation slab to provide a full basement work floor.

The main bin hopper bottoms are supported on radial pilasters or pillars arranged about the inner periphery of the bin wall. The patent drawings show pilasters that are integral to the wall and could be slip formed along with it. Alternatively, the patent covers radially arranged pillars that could either be integral to the wall or freestanding. The pillars or pilasters support an "annular compression ring" from which the conical steel bin bottoms were suspended. The patent drawings show this member to be a ring of channel section steel. The ring sits above the pilasters on blocks of I-section steel. Where columns rather than pilasters are employed, the patent specifies that the hoppering may be supported by a "peripheral reinforcing member surrounding and rigidly attached to the periphery of the hopper bottoms." This is thought to refer to the concrete ring girder featured in all other Budd derivative designs in Buffalo.

The advantages of the design were considerable and took full advantage of the behavior of grain in deep bins. The weight of the grain on the hopper bottom of a deep bin is limited by the relationship between the diameter of the bin and its depth. The hopper bottom only has to support the weight of grain to a height in the bin equal to the diameter of the bin, together with the weight of the grain within the hopper bottom itself. In the Budd design, the basement pilasters or pillars only have to be dimensioned to carry this relatively small load. The weight of the grain above this point is transmitted by intergranular friction to the side wall of the bin through which it is transferred compressively to the foundation slab. As these loads are transmitted in direct compression to the foundation slab, there is no need for heavily reinforced slabs and beams dimensioned to transmit bending moments.

Economical ring foundations could be used because structural and live loads are carried to the foundation slab almost exclusively by the bin walls. The ring girder carries both compression and bending moments. The steel plates of the hopper carry tensile loads that are resolved within the hopper bottom into a direct compressive load. The hopper is thus self-contained and merely rests on the supporting ring girder. The design dispensed with costly and time-consuming conventional basement construction and allowed the entire structure to be raised more conveniently and cheaply by slip forming. Although the design provided adequate basement headroom, the working space within the basement was impeded by the bin walls which necessarily extended below the hopper bottoms to the floor slab. Communication between each bin "cell" was provided by openings for both conveyors and personnel.

The contract for the construction of the first stage of the intended complex was signed with the James Stewart Company in January, 1925. It was to be built to the design of company resident engineer, T.D Budd, with A. E. Baxter acting as supervising engineer. The building permit was issued in April, 1925. By this time, work was already well advanced on the foundations and the pouring of the caissons was accomplished within the month. The elevator was complete and operational in December of 1925.

The 340' x 70' building was slip formed from the foundation slab using Folwell Sinks type jacks. The design of the basement called for complex slip forming procedures. Pilasters were cast monolithically with the bin walls, resulting in a distance between the inner outer forms greater than elsewhere. Once the structure had risen above pilaster height, fillers were inserted between the forms so that standard 8" walls were constructed above the pilasters. The coincidence of both basement conveyors and personnel passages with the location of jacking rods required the temporary blocking of these apertures to relieve the strain on the exposed jacking rods unsupported by encasing concrete. Once the work had proceeded to full height, the blocking was removed and the exposed jacking rods cut away. Where the main bins were vertically subdivided, additional forms were activated above the ring girder to produce square inner bins and radially arranged subdividing walls. These forms had been carried with the main forms from the foundation slab but the supply of concrete to them had been "choked off."

Marine "A" provides an early example of all concrete slip formed workhouse construction. The workhouse forms were carried from the foundation slab with the main bin forms and various sections were activated according to need, particularly for the pouring of beams. At bin floor level, a monolithic overall slab was cast using the working platform as the base of the form. The bin floor was protected by a single-story concrete gallery which was added using conventional fixed form techniques. The construction of the workhouse continued to full height using slip forms. At bin floor level, additional form work was added to extend the workhouse over the main bins. This form work was designed to provide for both the monolithic construction of concrete garner bins at the top of the workhouse, and the large concrete beams required to bear the weighing and elevating machinery.

The specifications called for the proportioning of material by hand and the mixing of concrete in batch mixers. Water was added to "make the mix fluid." The mixture was immediately placed in horizontal layers that did not exceed 12". No mechanical vibrators were used, and the concrete was well spaded to expel air and ensure that no voids were set in the concrete. The reinforcing steel was tested by an independent engineering company.

The estimated cost of construction was $250,000, providing storage at a cost of 25 cents per bushel. At this date, the cost advantages of the bin wall basement design were yet to be established. Contemporary conventional bin slab basement column designs cost between 21 and 23 cents per bushel of storage, while bin slab basement wall elevators were only 18 cents per bushel.

The total capacity of the Marine "A" Elevator is 2,042,600 bushels. The bins are arranged in three interlocking rows placed in diagonal tangential contact. The outer row is comprised of eight cylindrical bins and the inner row seven. These are 30'-6" in inner diameter and are arranged on 44' centers. The bin walls rise to a height of 120'. The undivided main bins have a capacity of 67,000 bushels. A row of six interspace bins forms the center line of the structure between the main bins of the center row.

The bins are of conventional form and have four convex walls, two of which are segments of the inner row of main bins and the remaining two of the outer rows of main bins. Together, these bins have a capacity of 16,800 bushels. Sixteen outerspace bins are located between the main bins--seven along each elevation and one on each end wall. They are of large volume, having a capacity of 28,800 bushels. This capacity results from the wide spacing of the main bins in relationship to their diameter, and the extension of the outerspaces deep into the structure so that the rear wall of the bins is formed by a segment of the inner row of main bins. The outer walls of the outerspaces are of conventional convex form, built to the same radius as the main bins and extended over one quarter of the circumference. The spacing between the main bins of the outer row is such that both main and outerspace bins present identical aspects to the exterior elevation, each part cylinder extending over a quarter circumference. In most other Buffalo elevators, the exterior wall of the outerspace bins occupies less that one-fifth to one-sixth of the circumference of the main bins.

The southernmost transverse row of bins lies below the workhouse and effectively provided for workhouse rather than storage functions. The southeast and southwest main bins are divided horizontally to accommodate cleaning machinery at half height. These bins are also divided vertically above and below the cleaning floor, a form of subdivision unique in Buffalo. A small square bin is placed centrally within the cylindrical bin. The area between the square and cylindrical bins is divided into four quadrants by four radially arranged dividing walls. The cleaning floor is at a height of 73'-6" above the floor slab and is 18' high. The upper set of bins provides the feed to the cleaning machinery and is 42' deep. The upper square bin has a capacity of 2,420 bushels, and the upper quadrant bins a capacity of 5,200 bushels. The lower set of bins varies between 53' and 57' in depth and receives grain from the cleaners. The lower square bin has a capacity of 2,660 bushels, and the lower quadrant bins a capacity of between 6,100 and 6,400 bushels.

According to the original design, the end outerspace bin below the workhouse was not to be subdivided and was to have a capacity of 27,700 bushels. As built, it was divided above and below the cleaning floor into bins of 9,450 and 11,675 bushels respectively. The original design shows that further subdivision of the main storage bins was intended. Within the central row of main bins, alternating bins were to be vertically subdivided for their entire height in a similar fashion to those below the workhouse. The four bins so divided were to have a central square bin of 6,775 bushels and four quadrant bins of 14,150 bushel capacity.

The bin walls rise directly from the floor slab to the bin floor at a height of 125'. However, the depth of the bins is less than this as the bin bottoms are raised within the bin. With the exception of the subdivided main bins below the workhouse, all main bins feature hopper bottoms constructed in accordance with the Budd patent drawings. A plate steel conical hopper extends across the width of the bin and rests on eight pilasters incorporated into the interior of the bin walling. The pilasters are placed equidistantly at 40° intervals about the circumference of the bin wall. They extend to a height of 13' above the foundation slab and are 8-1/2" x 3'-6". An annular channel section "compression girder" measuring 22" x 4" runs around the inside circumference of the bin walls and rests on 4" x 6" I-beams placed above the head of the pilasters. The conical steel plate hopper is hung from the compression girder by suspending plates. The hopper plates are riveted together and bolted to the suspending plates. To ensure a tight fit, the steel hopper is mortared to the wall and finished to the hoppering angle. The hoppers are angled at 37° and the draw-off is arranged centrally. The depth of the main bins measured from the hopper draw-off to the bin floor is 120', the bins extending at full width for 110' above the hopper bottom.

The interspace hopper bottoms are inverted pyramids of flat steel plate. They are raised above the foundation slab within the bin walling and rest on short girders that span the corners of the interspaces. The interspace bins discharge centrally. These bins, with a total depth of 119' measured to the draw-off spout, extend to the full width of the interspace for 115'. The outerspace bins have flat plate hopper bottoms and are also raised above the foundation slab within the bin wall. The hoppering is supported on longitudinal steel beams spanning the outerspace. It is arranged to provide a discharge in line with that of the outer row of main bins, making the hoppering notably asymmetrical. A plate steel hopper similar to that of the interspaces is located toward the inside of the bin. This is fed by a single large sheet of steel inclined at a lower angle and placed toward the outside of the bin.

The subdivided main bins below the workhouse were originally to have been hoppered in a similar fashion to the other inter- and outerspaces. The subdividing walls were to extend to the floor slab and the hoppers were to be suspended within these walls. When the subdividing walls do not extend through the basement, hoppering is provided by a curved concrete slab spanning the width of the bins. The slab is elevated to provide full basement headroom and is supported by longitudinal concrete girders. In this area the walling of both main and outerspace bins only extends through the basement, where it shares a wall with an adjoining bin. This means that the walling that would extend through the basement of the workhouse is absent, and a large continuous open space is provided in this area. The truncated bin walls terminate in pillars and the loads are transmitted to the foundation slab in part by transfer across this section of the basement to the workhouse structure.

The mixture of concrete specified for the bin wall varies with height, and Marine "A" appears to provide an early example in Buffalo of this subtlety of specification. From the foundation slab to the top of the pilasters at 13' the mixture is 1:1:2, above 21' it is 1:2:4, and between 13' and 21' it alters progressively between 1:1:2 and 1:2:4. The wall thickness is 8", except where it thickens to 16-1/2" in the pilasters. The tangential thickening about the bin contacts is 11' long and the minimum wall thickness here is also 8". That part of the bin wall within the basement is pierced by 8' longitudinal conveyor passages, which align longitudinally beneath each of the three rows of main bins. Every bin wall of the inner row is pierced by 2' wide transversely arranged personnel passages. In all main and outerspace walls, the exterior wall is pierced at basement level by two upright window lights. Both main and outerspace walls are strengthened at basement level by a single external pilaster measuring 4' x 6".

The vertical reinforcing is a combination of jacking rods and ordinary verticals, with the density of ordinary verticals increasing in the exterior walls. The jacking rods are of non-deformed smooth new billet steel, and eight are placed equidistantly on 12' oenters about the circumference of the main bins. The jacking rods are located at the point of tangential contact between bins, and in the exterior walls close to the point of contact between outerspace and main bin walls. Intermediately they are located at the point of intersection of the bin wall with the transverse and longitudinal center lines of the bins. The jacking rods at the point of tangential intersection are 1-1/4" in diameter, while the intermediate rods are 1" in diameter.

The Marine "A" Elevator appears to provide the only known example in Buffalo of a variation in size of jacking rods according to their position within the structure. Along the exterior walls an additional jacking rod was employed so that two rods could be placed in close proximity to either side of the exterior wall pilaster. The ordinary verticals are made of deformed re-rolled rail. In the interior wall three ordinary verticals of 1/2" round rod are placed equidistantly on 4' centers between the jacking rods. In the exterior walls, seven similarly dimensioned verticals are on 18" centers between the jacking rods. The verticals are in 16'-8" lengths and are lapped and wired together. All vertical steel is centered 2-1/2" from the outer surface of the walls to ensure that the horizontal steel wired to the outside of the verticals has a cover of at least 1-1/2" of concrete.

The horizontal reinforcing is the usual discrete tank bands, of graduated size and arranged at differing course intervals according to the predicted changes of tensile stress with height. All horizontals are deformed round rod of re-rolled rail grade. The horizontal reinforcing in the first 14' of walling consists of fourteen courses of 1/2" rod on 12" centers. At this height in the structure, this provides basement rather than bin walling.

There are 224 tank bands in the bin walling above the ring girder. From 14'-6" above the floor slab to 80'-6" above the slab, there are 132 courses of 3/4" rod at 6" course intervals. Above this point and to the top of the bins, the coursing interval returns to 12". To reflect this significant change in course interval, the rod size increases to 95'-6" for the next fifteen courses above the floor slab. At this point, rod size diminishes for the next fifteen courses to 110'-6". For the uppermost fifteen courses above 110'-6" the rod size is further reduced. The individual tank bands are comprised of three bars bent and lapped together. The length of lap increases with rod dimension; the length of rod varies from 27'-8" to 28'-4". The bands of adjacent bins overlap at the point of tangential contact, where they pass to either side of the jacking rod placed at this point. Single contact anchors at the extremities of the contact thickening provide a tie between adjacent bins. These are placed at every course and bent about the two verticals located at the extremity of the tangential thickening. These anchors feature unusually long tangs which extend for 4'-6" into the ordinary 8" thick bin wall to hook behind the next set of verticals.

The horizontal reinforcing of the outerspace bins is coursed as in the main bins, but consists of 1/2" rod throughout. Each band is a single 26' long rod bent back at its ends to form a tang that hooks around the jacking rods at the point of intersection between the outerspace and main bin walls. No additional contact anchors are employed at this point. The bins are capped by an overall monolithic concrete bin floor supported by I-beams.

The elevator is built on circular caissons that extend to rock at about 15' below the floor slab. The caissons are 5' in diameter and support a network of foundation beams. A caisson is placed below the intersection of main and outerspace bins and below all exterior pilasters. Below the interior walling, the caissons are placed below the extremities of the area of tangential bin wall thickening. The caissons support four sets of longitudinal foundation beams. Two sets of beams are located below the exterior bin walling and two follow the line of the interior basement bin walling. The result is a continuous longitudinal wall of alternating convex and concave segments formed from the outer part of the inner bin row and the inner part of the outer bin row. The beams are 3' x 5' and reinforced by fourteen non-trussed rods. The 6" floor slab above the foundation beams is reinforced by a graduated grid of rods. All foundation works were completed in 1:1-1/3:2 concrete and reinforced by deformed re-rolled rail.

A 14' high single-story concrete gallery extends the full length of the bin floor. It is placed about the center line of the structure and is 31' wide. The gallery is of conventional pillar beam and slab reinforced concrete construction. The walls are integrally cast concrete panels reinforced by a grid of 1/2" rods on 18" centers.

The reinforced concrete slip formed workhouse at the southeast end of the building extends to a height of 190'. The lower part of the workhouse measures 15'-6" x 44'-9" and accommodates three elevating legs, stairs and a personnel elevator. At a height of 63'-6", the cleaning floor extends across the structure and forms part of the same floor that subdivides the adjoining transverse row of bins. Above the bin floor, the structure extends over and above the first transverse row of bins and measures 35'-6" x 44'-9". This part of the workhouse has two floors; a full scale floor at 150' and a half machinery floor at 182'-6". Both floors are supported by slip formed beams of 6'-3" and 2'-3" depth respectively. Three 2,500-bushel concrete garner bins are integral with and located at the top of the structure. The 19'-6" x 14'-6" bins are 19' deep (23'-6" to the draw-off), and their concrete hopper bottoms are supported by 4'-6" deep concrete beams. Each bin is equipped with four draw-off spouts. All workhouse walls are 8" thick.

To the west of the workhouse is a structural steel railroad loading shed measuring 85' x 90' and accommodating four tracks. A bagging house for the sacking of dust is located above the shed within the rise of the pitched roof. The elevator is equipped with two movable marine towers of structural steel. Because they contain re-elevating machinery, these rise to a height of 175'.

The northeast main bin, the end bin beside the river, is sub-divided horizontally to accommodate grain drying and cooling equipment. This bin was originally a typical main bin and was only converted to its present form in 1955. The Norris Grain Company commissioned this work soon after it took over the Abell corporation in Buffalo. The conversion work was carried out by the Metcalf Company of Chicago.

The lowest 34' of the original bin was retained as a receiving bin and a series of floors and half floors inserted above 34'. The lowest was the cooler floor supporting two sets of cooling machinery. Above this, a half floor supported the burners. Next came an overall heater floor with an upper heater half floor above. These floors accommodated two sets of driers. A new concrete hopper bottom was inserted above the driers so that the uppermost part of the bin could be used for feed storage. The new hopper bottom had four draw-off spouts to supply each set of machinery.

BUSINESS HISTORY

Charles Lee Abell, founder of Buffalo's Marine Elevator Company, was born in Buffalo in 1856. After receiving his early education in the city's public schools and attending college in London, Abell worked for several companies. At age sixteen he was employed by C. A. Blake & Co., London wholesale miners and shippers of coal. Five years later, he spent two years with the Western Elevating Co., the Buffalo grain elevator owners' association. He left Buffalo to work in the Bradford, Pennsylvania oil field with National Transit Co., transferring back to Buffalo as clerk to the pipeline superintendent. He left that position in 1880 to supervise the construction of the 150,000-bushel Marine Elevator being built by his father, William Hawks Abell, and Daniel O'Day, manager of National Transit.[2]

The elevator company was not officially incorporated for another fourteen years. In March, 1894, C. L. Abell established the joint-stock company that began with $201,000 in capital stock to build and maintain grain elevators, store and handle grain, and build and maintain docking for vessels. The primary owners were Abell and O'Day who each held 670 shares of par $100 stock. In addition to the two dominant shareholders, the directors included Philos G. Cook, Jr., secretary/treasurer of the Western Elevating Company, H. St. Clair Denny, a broker in investment securities specializing in iron and coal, Chauncey Talcott from the Southern Tier town of Silver Creek, and attorney Otto W. Volger from Wardwell, Volger & Wardwell in Buffalo.[3]

By September, 1894, with over half the capital fully subscribed, the stockholders (who now included Emma Abell and Hattie E. Towers) voted to take a $100,000 loan from Fidelity Trust and Guaranty Company. The loan was to be secured by a mortgage, but the precise terms were not revealed. However, the company's general prosperity was reflected in the rapid repayment of the $100,000 mortgage over the next seven years; the annual reports showed the company's total debt reduced from $118,000 in 1895 to $22,000 in 1901. The original mortgage was drawn to finance an addition to the first Marine Elevator that increased capacity to 650,000 bushels. The company also added a traveling marine leg to facilitate grain unloading from Great Lakes freighters.[4]

In 1911, the company expanded its functions considerably by amending the certificate of incorporation allowing it to engage in securities sales as well as operating the grain facilities. The proposal to make this change came from forty-one-year-old Henry S. Norris, a director of Marine Elevator and superintendent of New York Transit Company. Norris was also agent of Union Tank Line Co. and in 1920 secretary of Iroquois Natural Gas. Not a grain trader by background, Norris was peripatetic in his financial interests. He was one of the more enduring directors, with a position on Marine Elevator's board of directors spanning the decades from 1907 to 1948. Abell may have had considerable influence over Marine Elevator's financial course, but there was no apparent relation between him and the giant Norris Grain

Company interests in Chicago that later absorbed the Marine Elevator Company.[5]

In 1916, Marine Elevator purchased the site where it would later build a concrete elevator. The 6-3/4 acre parcel had excellent 750" docking facilities along its 1,145" river frontage. Before the company could erect the new elevator itself, C. Lee Abell became ill, and in 1919 his son, Harold L. Abell, assumed active control of the company. Prior to his father's illness, Harold had spent most of his time with the collateral family businesses, Union Fire Insurance, the C. Lee Abell Co., also an insurance company, and others. Harold was not known for his business acumen, but when C. Lee Abell died in October, 1920, he was left to run the concerns with secretary and treasurer Edward J. Nolan. Other 1920s directors included attorney Norris, attorney Edward L. Jellinek, Marine Trust Co. Vice President William A. Strong, and investment broker Russell J. H. Hutton of Schoellkopf, Hutton & Pomeroy. They were joined by Thomas C. O'Brien, formerly with Williamson Forwarding Co. and later a director of Superior Elevator. None of the directors, much less Harold Abell, had extensive experience with the grain trade. The lack of clear business direction would have an impact on the company in the future.[6]

On April 7, 1925, the company increased its capital stock from $201,000 to $1 million, and, on the 16th, consented to a $1.5 million first mortgage with Buffalo Trust Company to be secured with gold bonds. This mortgage was used to finance the construction of its first concrete elevator, the 2,050,000-bushel Marine "A" Elevator. The new facility was entirely independent of the original building and had thirty tanks, twenty interstitial bins and twenty-nine additional workhouse bins. Its greatest advantage--rapid handling--made the Marine "A" very desirable to shippers. The elevator was open for business in 1926 and operated successfully for a number of years.[7]

Marine was a publicly-traded company offering both stocks and bonds on the New York Stock Exchange. In 1931, two years after the beginning of the Great Depression, its self-reported financial picture indicated a small but healthy income surplus from 1929 to 1931. Its debt at this time consisted of the $1.5 million that was backed by gold bonds issued by the primary creditor, Buffalo Trust and its successor, Marine Trust. The local brokerage, interlocked with Marine Elevator, Schoellkopf and Hutton & Pomeroy, had also made $900,000 of the debt available to public sale in 1925. The strict terms of bond interest payment indicated that Marine Elevator, while reasonably sound, was not considered a superior financial risk. The company was to pay no dividends except from earnings accrued after

January 1, 1926, and then only if profits exceeded principal and interest due to Marine. It was to pay Marine $2 for each $1 in dividends in excess of $100,000 until 50 percent of the bond was retired.[8]

By 1940, Marine Elevator was in trouble. In August of that year, the company was sued by Marine Trust Co. on behalf of the bank itself and 350 individual or institutional bond holders. The suit moved to foreclose the trust mortgage on the Marine Elevator of which $550,000 in bonds remained unpaid. Over $225,000 in principal was held by three individuals--Mark Becker, Reginald B. Taylor, and Edwin J. Schwanhaussen--while $65,000 was owned by Niagara Power Land Co. and $87,000 by other bondholders. In addition, the elevator company owed $90,000 in past-due city and county taxes. Under terms of the suit, Supreme Court Justice Alonzo G. Hinkley was assigned as trustee to continue operation of the elevator properties. Harold Abell was thus effectively removed from control if not ownership.[9]

In 1944 the company filed for Chapter X bankruptcy. The plan for reorganization made public in September included a new mortgage to cover money owed, not to the bondholders but to Harold Abell of the C. Lee Abell Company, and to Edward J. Nolan, Secretary/Treasurer of Marine Elevator and an officer in Abell Forwarding, C. Lee Abell Co., and Union Fire Insurance Co. The repayment agreement offered $70 in cash for each $100 in bond and $15 for each $100 payable in twelve years or earlier if the elevator were sold. No payment was offered to stockholders. Marine Elevator had to take an additional mortgage to secure the cash. The mortgage was to cover a $350,000 bond and first mortgage debt owed to Liberty Bank and a $20,000 subsidiary lien. In 1945 the new trustee, James W. Persons, consented to the plan, but only because the note was secured by the debtor's real property and by Harold L. Abell's personal life insurance policy. It was a last-ditch effort to keep Marine Elevator functioning. The plan did not, however, appease those to whom the original debts were owed.

The payment schedule on the reorganized debt demanded monthly payments of at least $3,500 beginning in May 1945, and continuing through June 1, 1946. Each June 1 thereafter, the payments were to equal 75 percent of profits before depreciation but after federal taxes. To raise more working capital, the trustee authorized an increase in capital stock and a reclassification of stock types. The actual increase was from $1 million to $1,108,000; the reorganization allowed mortgage holders to have $400 cash and one share par $100 preferred stock for each $500 in principal they held in unpaid, unmatured bond coupons.

The new stock issue threatened to "water" the existing stock, and the repayment threatened to enrich the company at the expense of those owed money. Therefore, creditors secured a proviso that the only exception to the reorganization plan was the corporation itself, which could not redeem its own bonds held in the company's treasury. Further, all stock was to have voting power, and reports to stockholders were demanded. The bankruptcy trustee's reorganization put severe restrictions on the company to prohibit the freewheeling "insider" dominance of the Abell family's earlier days.[10]

Harold L. Abell's obituary noted that he had opened Marine "A" in 1926 with a luncheon for 500 guests and was active in all of the leading social clubs in Western New York. Perhaps the restrictions on his company and his largesse were too much for him; Abell died twenty-five days after the bankruptcy reorganization was effected on April 13, 1945. His death drew a curtain on the Abell family influence in Buffalo's grain trade.[11] In 1947 the company reduced the value of its common stock and eliminated preferred stock. This undermined existing value but also reduced the company's dividend commitments. Although the Board adopted the measure to generate surplus that could once again be within the company's control, the tactic had no appreciable benefit.[12]

In April, 1954, Marine Elevator Co., the last big locally-owned grain firm, was sold to the Chicago-based Norris Grain Company with elevators in Chicago, Duluth, Toledo, Kansas City, St. Louis, New York, Baltimore, Minneapolis, and Peoria, Illinois. The stockholders, primarily Abell family members, voted on the sale. None were involved in direct elevator operations and, as with Concrete Central Elevator heirs, appeared to prefer liquidating their assets through an outright sale. By October of that same year, the company filed for dissolution and over the next three years it finally settled all creditors' claims against the company. In November, 1957, the final petition was accepted and Marine Elevator Company ceased to exist.[13]

Norris's interest in Marine "A" Elevator and its parent company lasted only eight years. Norris ceased production in Buffalo in 1962 due to declining grain transfer activities. The elevator remained idle for over a decade; in 1974 it came into legal troubles for back taxes and was taken over by the City of Buffalo. Local attorney Glenn A. Claytor bought the abandoned facility from the city in 1985 and has retained control of Marine "A" to the present time. Claytor has engaged engineering studies that would allow him to convert the property from grain storage to a fresh-water marine hatchery to supply the city's restaurant trade with fish free from the contaminants present in the Great Lakes. To date, Claytor has been unable to realize this program, but his plan is still active, and he hopes to revitalize the elevator for those uses.[14]

MATERIALS HANDLING: HISTORY AND DESCRIPTION

The trade publications describing the construction of Marine "A" stressed the significance of its well-balanced layout for swift transshipments: "Conditions at Buffalo are such that rapidity in handling grain is vital in establishing the desirability of any one elevator...under certain conditions [this] elevator will be able to receive at the rate of 60,000 bushels per hour and at the same time can deliver grain into cars, barges or lake boats."[15] Such mechanical efficiency and the resulting economic viability was contingent on the design capacities and synchronization of elevating and conveying equipment units, including the marine legs, workhouse lofter legs, storage and shipping conveyors, weighing apparatus and grain conditioning units.

The principal subcontractors for machinery under James Stewart & Co. were the Webster Manufacturing Co. and the Weller Manufacturing Co., both based in Chicago, the B. F. Goodrich Rubber Co. of Akron, Ohio, S. Howes Co. of Silver Creek, New York, and Westinghouse Electric. Webster furnished the elevating machinery and workhouse equipment, Weller the belt conveyors and trippers, and B. F. Goodrich about four miles of belting. S. Howes manufactured the grain conditioning and dust collecting machines. The Westinghouse motors were chiefly of the squirrel cage induction type and featured leakproof bearings with newly-developed sealed sleeves. Three-phase twenty-five-cycle alternating current was received at 2,200 volts and transformed to lower voltages for operating motors and lighting systems. Except where noted, all motors ran at 720 rpm. The twenty-one original motors for major grain handling units aggregated 1,855 hp.

Marine "A" has been derelict for over twenty-five years, and its deteriorated machinery subject to scavenging. The marine towers and headhouse remain extant.

Receiving by Water

Grain delivered on lake vessels was unloaded by two movable marine towers traversing the elevator's dock along the south bank of the Buffalo River. The towers were constructed of sheet metal cladding over a structural steel framework. When first placed in service, each marine leg was capable of elevating grain at an optimal rate of 30,000 bu./hr. "on the dip" (i.e. without using the ship shovels which reduced overall handling capacity); actual performance of 33,000 bushels was recorded during the early years of the facility. This unloading capacity was approximately three times greater than Marine's older wooden elevator on Hatch Slip.

Each marine tower traveled along the dock on twenty pairs of wheels over four heavy rails. Electrical current was originally transmitted to extension arms on the towers via a three-wire, bare copper trolley system on the cupola roof. A single motor in one of the marine towers was rigged to move both structures; the motor was driven from the ship shovel countershaft by roller chain and friction clutch. When only one tower was to be moved, car wheel stops were left in place under the tower that remained stationary.

The marine leg in each tower carried grain from vessel to elevator in twin staggered rows of 15" x 8", 8" deep Buffalo buckets spaced on 12" centers. The crosshead could travel up and down a maximum of 70' on its vertical rail. The crosshead-leg assembly was counterweighted, the weight being suspended by 3/4" steel cables running over sheaves. A 150 hp motor located at the crosshead powered each marine leg through a link belt double chain drive, using a roller chain for the first reduction and a silent chain for the second. Each hoist and pusher mechanism for controlling the position of the leg within the ship's hold was driven by a 30 hp motor located on the fifth floor of the marine tower. Power was transmitted through the hoist countershaft and a pair of pulleys, driving the hoist drum via pinion and the pusher via a pair of leather belts. An inclined screw operated the pusher. The mechanism consisted of a 5" brass nut on a 3-7/10" screw revolving at 133 rpm and receiving power through leather belts for direct and reverse drive to advance or retract the leg laterally.

The overall marine unloading rate depended on the speed of the ship shovels operated by the scooper gangs as well as the mechanical capacity of the marine legs. Each set of ship shovels was driven off shafting by a 100 hp motor, not the squirrel cage type used elsewhere in the elevator, with two speeds--720 and 360 rpm. The power transmission system for the ship shovels consisted of Stewart-Falk herringbone reduction gears with flexible couplings between the motor and reduction gear set as well as the reduction gearing and the shovel countershaft. Clutches for the ship shovels featured birch friction blocks.

Once grain had been raised to the top of the marine tower it descended by gravity through a weighing apparatus prior to reelevation by the internal marine lofter. After being discharged over the head pulley of the marine leg, grain passed into an upper garner above a 500-bushel flow-type steel hopper scale with counterweighted valve action; grain which had been weighed then flowed into a lower garner before reaching the boot of the marine tower lofter leg. Each marine lofter featured four rows of 14" x 8", 8" deep Buffalo buckets staggered on 13" centers and attached to a 60" eight-ply rubber belt. A 200 hp motor located at the head floor of the marine tower drove each lofter through Stewart-Falk herringbone reduction gear units and flexible couplings.

The marine lofters discharged through a traveling spout into the hoppers of continuous V-spouts atop the roof of the cupola over the main storage bins. By means of turnheads with a combination of fixed or portable spouts, grain collected by the V-hoppers was distributed into the bins or onto the receiving belts via traveling belt loaders. This system of V-spouts and turnheads serving multiple bins made it possible to transfer substantial amounts of grain into storage without either moving the marine towers or operating the receiving belts, thus boosting the overall handling rate and efficiency of the elevator. The nominal unloading rate of each marine leg remained constant at 30,000 bu./hr. until the eventual shutdown of the elevator.

Receiving by Rail

Though the Marine Elevator Co. did not anticipate unloading substantial amounts of grain shipped by rail, facilities were provided for transfer from cars to the new elevator. Four tracks entered the car shed at the southwest corner of the elevator and between each pair of tracks a car puller was installed for spotting boxcars over the receiving hoppers or under the car loading spouts. Each car puller was driven by a 50 hp slip ring variable speed motor with drum-type controller for ease of operation. Two pairs of manually-guided Clark automatic power shovels scraped the grain out of the cars and into the 1,000-bushel receiving pits located under the two tracks nearest the elevator. The power shovels were driven by a 30 hp motor through silent chain and gear reduction. A 36" receiving belt transferred grain from the car pits to the boots of the workhouse lofter legs. This conveyor was driven through reduction gearing from the same motor that operated the car shovels. Initial rail receiving capacity was estimated at 2-1/2 cars unloaded per hour.

Instore Distribution: Horizontal Transfer and Vertical Handling

Grain weighed in through the marine towers that did not require immediate reconditioning could be sent directly to storage via either the rooftop V-spouts and cupola turnheads or the receiving belts. The original storage conveyors on the bin floor consisted of two 48" reversible belts driven by 50 hp motors. These conveyors operated at 800' per minute and featured Stewart patent automatic take-ups to compensate for slackening and self-propelled four-pulley trippers with friction drives. Marine receipts could also be routed to the cleaner bins via the distribution belts.

Rail shipments unloaded at the car pits were elevated for weighing in the headhouse located at the south end of the storage annex. The workhouse contained three lofter legs, each having a capacity of 20,000 bu./hr. and carrying twin rows of 18" x 8", 8" deep buckets on 13" centers. The motors driving these legs were rated at 150 hp. Power was transmitted through herringbone reduction gears with flexible couplings between motor and gearing.

In the headhouse, each lofter discharged its load by gravity into a 2,500-bushel reinforced concrete garner with steel-plate bottom, hard maple valves and nine small gates. Below each garner was a 2,000-bushel steel-plate solid-lever flow-type hopper scale with double-acting plate valves. Below the scale floor in the headhouse a Mayo-type (articulated) spouting system distributed drafts of instore grain received by rail to nearby bins via turnhead, to more distant bins via the storage conveyors or to the cleaner bins if reconditioning was required. The turnheads were activated from the scale floor.

Grain Conditioning

Equipment for cleaning grain and clipping oats was situated in the cylindrical bins flanking the workhouse, midway between the first floor and the bin floor. These conditioning units were supplied with grain whose movement remained independent of the operation of the lofter legs. Cylindrical bin spaces above and below the cleaner story were divided into five smaller compartments, each holding about 5,000 bushels. Three of these upper compartments were designed to spout to a cleaner, the remaining two to an oat clipper.

Only one set of conditioning machines was installed initially--a 4,000 to 5,000 bu./hr. Invincible compound-shake double-receiving separator with automatic sieve cleaners and self-oiling bearings as well as a 1,500 bu./hr. Invincible Oat Clipper. At that time, the "Invincible" trade name was manufactured by the S. Howes Co. which had acquired the neighboring Invincible Grain Cleaning Co. in 1924.[16] A 50 hp motor drove the cleaner through belting while the clipper was powered by a 75 hp unit running at 475 rpm. At normal operating rates, the cleaner could draw on the independent supply bins above for a period of several hours, while the clipper might function on its own for an even longer portion of the day or night. Turnheads below the cleaner floor directed reconditioned grain to the divided receiving bins. Bypass spouts from the bin floor allowed use of the lower cleaner bins for direct storage if necessary. Grain from the cleaner receiving bins was eventually spouted to the house lofters for reelevation to storage or weighing out.

Marine "A's" reconditioning capacity was augmented during the 1930s by an additional cleaner and a bleacher. After Norris Grain Co. acquired the elevator, the Metcalf Construction Co. of Chicago installed a gas-fired grain drier in the northeast circular storage bin in 1955.[17] Two fan motors of 30 hp each were located on the upper and lower heater floors within the modified silo, while a 40 hp motor was situated on the cooler floor below.

Shipping by Water

For transhipping grain to vessels transiting the New York State Barge Canal or the Canadian Welland Canal routes, Marine "A" was initially equipped with two dock spouts located at the north and south ends of the elevator. For handling grain between the storage bins and the house lofters, the elevator was provided with three 42" shipping belts located in the basement. Each belt was placed under a corresponding row of large circular tanks. As on the other conveyors supplied by the Weller Manufacturing Co. the rolls on the shipping belts turned on ball bearings. One of the shipping belts was designed to discharge to all three lofter legs. Each basement conveyor was driven by a 30 hp motor through herringbone reduction gears; maximum operating speed was 800" per minute.

The outstore shipping loop was completed by routing grain up the house lofters, down through the headhouse garners and scales, and then to the dock spout bins via distribution spouting or the upper horizontal transfer conveyors. Each vessel loading spout was initially designed to handle up to 30,000 bu./hr.; this nominal rate may have been pushed to 40-45,000 bushels during the 1930s on such occasions as the constricted interlake grain flow warranted. One of the dock spouts was taken out of service after World War II, and the capacity of the remaining spout was thereafter listed as 20,000 bu./hr.

Shipping by Rail

Handling grain for loading into rail cars involved a shipping sequence consisting of basement shipping belts, house lofter legs, headhouse garners and scales, distribution spouts and car spouts. Once grain had been conveyed from storage horizontally, reelevated and weighed in carload drafts, a turnhead below the outstore scale directed the flow out of the headhouse and through the car loading spouts. There was one spout for each of four car shed tracks, and each terminated in a bifurcated Sandmeyer-type attachment for filling both ends of a boxcar simultaneously. The track shed was arranged so that up to fifty cars could be set and loaded without a break for switching. The elevator's original carloading capacity was 40,000 bu./hr., a rate equivalent to filling 200 boxcars over a ten-hour period. This nominal rate remained unchanged for the duration of Marine "A's" operating lifetime.

Dust Collection

To guard against potential explosions, grain dust was collected and removed through a combined floor sweep and exhaust fan system. The fan suction system was designed to eliminate dust clouds at their point of origin, while the floor sweeps removed accumulated dust from throughout the building.

A dozen sweeps were located on each bin floor where grain was transferred to storage from spouts or belts and in the basement where grain was drawn from the bins onto the shipping belts. Other sweeps were sited at the lofter leg boot tanks, the receiving pit tunnel between the car shed and the elevator, the scale floor in the headhouse and the cleaner floor. Dust collected through the floor sweep system was conveyed to a bag house over the track shed for sacking; it is uncertain whether loose dust could also be spouted directly to railway cars. The bag house could store two carloads of sacked dust. Bag house equipment included a Giant Dust Packer by S. Howes Company.

The original Budd-Sinks suction system included fans mounted on the shaft of each house lofter leg motor at the head floor. After extracting dust from the garner into which each leg discharged, these fans directed both light and heavier particles into a cyclone above each garner. Coarser dust, which retained economic value, was recycled back into the garner for weighing, while lighter, potentially more explosive dust, was vented into the atmosphere. On the cleaner floor, a 60" exhaust fan was connected directly to the same 50 hp motor operating the original cleaner. Cyclone dust collectors for the cleaners and clipper were located above the track shed and bag house; each cyclone terminated in a small bagging spout. To further reduce dust generation and accumulation, the garners and scales in the marine towers were also fitted with vents patented by James Stewart & Company.

ENDNOTES

1. The following paragraphs are based on a variety of sources including city building permits, contracts and plans housed in Buffalo City Hall. Additional plans were inspected courtesy of Henry Baxter. The elevator is described in Grain Dealers Journal, Special Plans Book, 5 (1942): 161 and in American Elevator & Grain Trade 43 (15 April 1925): 663.

2."The City of Buffalo--Its History and Institutions," Buffalo Morning Express Supplement to Celebrate the International Industrial Fair (Buffalo: Matthew Northrup & Co., 1888), 36; Buffalo Courier-Express, 16 October 1921, p. 5; The American Elevator and Grain Trade, XLIV/10 (15 April 1926): 611-12.

3. Erie County Clerk (ECC), Corporations, Marine Elevator Company, Certificate of Incorporation, March 3, 1894, Box 10092; Buffalo City Directory, 1895; Who Was Who, Vol. 1, pt. 2. All Erie County Clerk documents are listed by date of document origin, not by date of filing, unless otherwise noted.

4. ECC, Corporations, Marine Elevator Company, Consent to Mortgage, (filed September 10, 1894); Annual Reports, 1895-1901, Box 10092; The American Elevator and Grain Trade, XLIV/10 (15 April 1926): 611-12.

5. ECC, Corporations, Marine Elevator Company, Amended Certificate of Incorporation, April 18, 1911; Certificate of Election, 1907-1948, Box 10092.

6. American Elevator and Grain Trade, XLIV/10 (April 15, 1926): 611-12; Buffalo City Directory, 1920, 1926, 1930; Buffalo Courier-Express, 16 October 1920, p. 5.

7.American Elevator and Grain Trade, XLIV/10 (15 April 1926): 612-13.

8. Moody's Industrials, 1931.

9. BECPL, Scrapbooks, "Industry," Vol. 5, 80-82; Buffalo Courier-Express, 20 May 1944, p. 5.

10. ECC, Corporations, Marine Elevator Company, Certificate of Consent of Trustee, April 13, 1945; Certificate of Changes of Shares, April 13, 1945; Certificate of Change of Provisions of Certificate of Incorporation, April 13, 1945, Box 10092; Mortgages, Liber 114, pp. 237-43, 243-47; Buffalo Courier-Express, 20 May 1944, p. 5; Buffalo City Directory, 1925, 1945.

11. Buffalo Courier-Express, 8 May 1945, p. 22.

12. ECC, Corporations, Marine Elevator Company, Certificate of Reductions, March 6, 1947, Box 10092.

13. BECPL, Scrapbooks, "Industry," Vol. 8, p. 103; ECC, Marine Elevator Company, Certificate of Dissolution, October 28, 1954.

14. Inland Seas, 18 (1962), 149; ECC, Deeds, Liber 8230, November 19, 1974, p. 397 (cf. In Rem Action 7, D-92981 for back taxes); Liber 9503, October 30, 1985, p. 600.

15. AEGT, 44 (1926): 612.

16. Information supplied by Cindy Miller, part sales manager, S. Howes Co., Inc., Silver Creek, NY.

17. Building Permit #R055415 (7 July 1955).

SOURCES

Unless otherwise indicated by footnotes, descriptions of machinery and process flows have been derived from the following sources.

Buffalo City Directories. 1895, 1920, 1925, 1926, 1930, 1945.

Buffalo Courier-Express, 16 October 1921, p. 5; 20 May 1944, p. 5; 8 May 1945, p. 22.

Buffalo and Erie County Public Library scrapbooks, "Industry," Vol. 5, 80-82; Vol. 8, 103.

"Buffalo Has Important Increase in Grain Storage," American Elevator and Grain Trade, 43/10 (15 April 1925): 663-664.

Building Permits, Plans & Specifications, 301 City Hall #90551 (24 April 1925).

"The City of Buffalo--Its History and Institutions," Buffalo Morning Express Supplement to Celebrate the International Industrial Fair. Buffalo: Matthew Northrup & Col, 1888.

Erie County Clerk, Records, Erie County, NY.

Grain Dealers Journal, Special Plans Book, 5 (1942): 161.

Green's Marine Directory of the Great Lakes [title and publication data varies]
30th ed. (1938), 325-326.
32nd ed. (1940), 302.
34th ed. (1942), 343-344.
40th ed. (1948), 340.
44th ed. (1952), 340.
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Inland Seas, 18 (1962), 149.

James Stewart & Co. Construction Photo Album (1925) and William P. Engler Photo Album, both in private collection of Tony DiLeo, Buffalo, NY.

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War Department Corps of Engineers, U.S. Army and United States Shipping Board, [Transportation Series #1], Transportation on the Great Lakes (Washington: Government Printing Office, 1930), 227.

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Who Was Who. Vol. 1, pt. 2.

APPENDIX

Mainhouse

Cost:	$250,000
Foundation:	Caissons of concrete 5' diameter, supporting 5' x 3' foundation beams, reinforcement with 14 straight rods; 6" floor slab reinforced with graduated grid of rods of deformed re-rolled rail
Basement:	Enclosed within bin walls which rise from floor slab; 2/3 above grade; exterior walls pierced by upright windows; interior walls pierced by conveyor and personnel passages between bins; eight 14' high, 9" deep radial pilasters support the bin hopper directly, no concrete ring girder is present
Hoppers:	Conical steel bin bottoms to full width of main bins, flat plate hoppers below interspace and outerspace bins supported by steel beams
Bins:	Capacity 2,042,600 bushels Main bins, parallel interlocking rows of 8, 7 & 8 bins; cylindrical 30'-6" in diameter; height 124' from floor slab, 110' from top of hopper SE & SW main bins divided horizontally to accommodate cleaning machinery; vertically sub-divided above and below cleaners by radial walls and square inner wall to form 5 smaller bins; NE main bin sub-divided horizontally to accommodate drier and cooler with storage, garner and receiving bins Interspace bins: 6 along the center line between inner and outer main bins Outerspace bins: 1/3 circumference bins with interior wall formed by inner main bin Tangential intersection between all bins, 11' long Wall thickness 8", at intersection 8" Vertical reinforcement, centered 2-1/2" from exterior surface; 8 round jacking rods of smooth new billet steel, 4 at 1-1/4" diameter at bin intersections and 4 at 1" diameter elsewhere; ordinary verticals of 1/2" round rod at 4' centers within interior walls and 18" centers within exterior walls; horizontal reinforcing wired to outside of verticals of deformed re-rolled rail; graduated round rods at variable course intervals; bands of adjacent bins overlap within the contact

wall, sharing a common vertical; contact anchors of round rod bent about verticals and coursed as main walls

Gallery: Monolithic concrete; reinforcement grid of 1/2" round rod at 18" centers

Workhouse: Monolithic concrete; garner hoppers of monolithic concrete with reinforcement grid varying to reflect stresses

REFERENCES: Army Engineers microfiche and copies of original contract and plans are housed in Buffalo City Hall. Additional plans were inspected courtesy of Henry Baxter. Dates are from city building permits, costs from City Plans Book for 1925. The elevator is described in Grain Dealers Journal, Special Plans Book 5, (1942): 161 and in American Elevator & Grain Trade, 43 (15 April 1925): 663.