PRELIMINARY STUDY INFORMATION
FOR STAFF REVIEW

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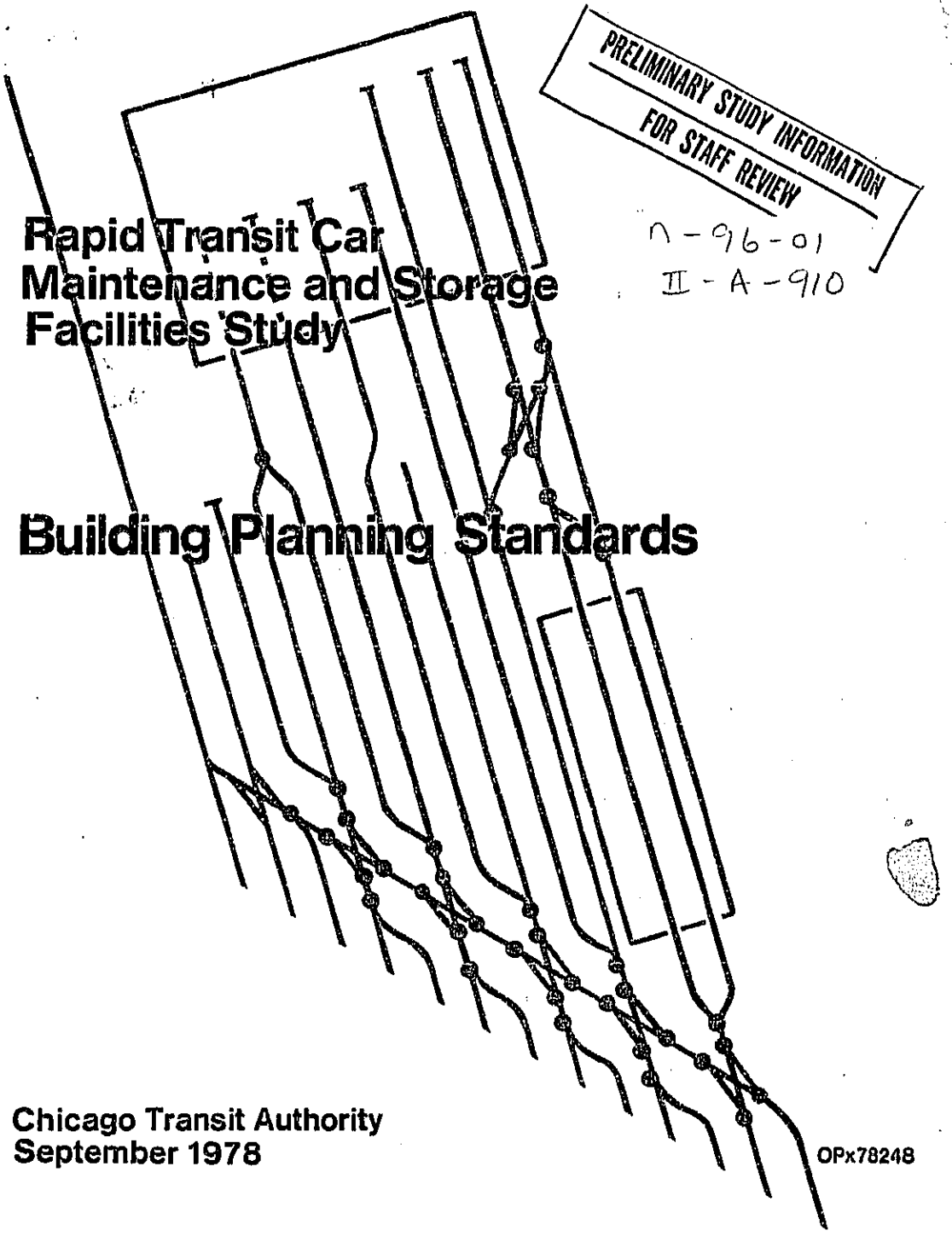
Rapid Transit Car Maintenance and Storage Facilities Study



Building Planning Standards

Chicago Transit Authority
September 1978

OPx78248

Rapid Transit Car Maintenance and Storage Facilities Study

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The findings and conclusions expressed in this publication are those of the Chicago Transit Authority and not necessarily those of the United States Department of Transportation, Urban Mass Transportation Administration.

Chicago Transit Authority

September 29, 1978

To: Operations Division and Department Managers

From: Howard P. Benn, Study Project Manager

Re: Draft Maintenance Building Standards

Attached for your review and comment is the third product of the Yard Study Task Force, the draft Maintenance Building Standards. (The first two items released from the Yard Study Task Force were the Skokie Shop Master Plan and draft Yard Standards.) It is respectfully requested that you return to me your comments by Monday, October 23. I am in Room 707 and can be reached on extension 844.

Howard P. Benn
Supervisor, Facilities Planning
Project Manager, J. O. 9262

HPB:ml
cc: Task Force Members
Study Participants
Attachments

PROJECT STAFF

This document is a product of work conducted by personnel of the Chicago Transit Authority.

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EXECUTIVE SUMMARY

This document contains standards covering four phases of maintenance building planning: Building Size, Productivity, Support Appurtenances and Ancillary Facilities, and Building Environment. Together, these phases constitute what the Task Force feels are the fundamentals of the maintenance building element in the yard.

The standards identify planning and design ideals which are to be included in the design/rehabilitation of maintenance buildings, where applicable. The key points to be noted in the maintenance building proposals are:

-- A well-laid out building with appropriate appurtenances and ancillary facilities is essential to improving labor productivity. Good facilities lead to improved labor productivity.

-- There is a definite mathematic relationship between cars assigned and building size. It was found that a relationship could be established where buildings proved to be too small or too large. What is important to note is that the outfitting of the building is as important as its size in keeping cars available for revenue service.

-- The accessibility to a shop building from a yard is as important as the arrangement of the maintenance building itself in keeping productivity at the highest possible levels.

-- It is important for the maintenance building to provide the facilities necessary to support the Planned Maintenance Program. To arrange these buildings in such a fashion (supporting PMP) is the other, terminal shop, side to the "Skokie Master Plan."

-- It is important for people and facilities to be available to perform required levels of maintenance at every terminal location; it is much preferred to concentrating certain facilities at only some terminals.

-- As compared with other properties, CTA has relatively small terminal shop buildings. But properly located, with good accessibility and good ancillary equipment, there is no reason for CTA not to continue to maintain the same relatively small maintenance terminals.

-- A key to car availability would be the ability for terminal shop buildings to handle maximum consist length trains in order to avoid cutting and adding to bring a defect into a shop building; equipment repair turnaround will be much quicker.

All of these elements taken together will produce two major advantages for CTA: they will help hold labor costs to minimum and they will improve availability of cars, thus effecting a better utilization of what we have, and in turn, a more effective use of our capital and operating funds.

INTRODUCTION

This document is a further product of the CTA "Rapid Transit Car Maintenance and Storage Facilities Study." Previous standards which have been produced covered Yard Planning Standards. This document is actually a subset of that, dealing with car maintenance facilities. General background and introduction to the study can be found in the Introduction to that document, OP-x78047. Also produced under the auspices of the Yard Study is the "Skokie Master Plan."

This report shares as its basis with the other reports, certain key concepts and goals. Primary among these is that capital investment should increase operations safety, reliability, and efficiency. From these Task Force concepts the following goals have been developed: to maintain the integrity of mainline and storage operations; to reduce the potential for conflicting movements; to simplify required movements; to increase operational flexibility; to minimize nonproductive vehicle mileage and manpower requirements.

A second concept is that employees as well as facilities should be protected and secured. This includes guarding against intruders, fire, weather, and such.

Capital investment will play a significant part toward improving employee working conditions, while increasing both operating and employee efficiency. Planning should provide for improved equipment and work facilities; for safer, predictable, and efficient movement; for adequate shelter; and for improved employee conveniences.

Finally, capital investment should also enable building maintenance of the same effectiveness or better to be performed at less cost. It is understood, of course, that all capital investment must conform to Federal requirements regard-

ing safety and environmental impacts.

For the purpose of discussion, the standards which follow have been divided into four groups: Size (S); Productivity (P); Support Appurtenances and Ancillary Facilities (A); and Environment (N). The distinction between one section and another is primarily editorial; for example, it can be easily understood that a recommendation pertaining to working conditions or equipment will directly impact employee efficiency.

Introductions to each section will acquaint the reader to areas of emphasis without repetition here. The size function factor is the most complex to apply, since terminal dimensions must accurately reflect schedule requirements; in practice, however, other locational restrictions often determine size, Fundamental concepts toward increasing productivity involve compact, flexible, accessible, well-equipped maintenance terminals. Standards in the second half make recommendations for equipment and working environment. Day-to-day maintenance required to keep the CTA fleet rolling is performed at maintenance terminals on each route (which correspond to service and inspection barns at some properties). Major rebuilding and overhaul is accomplished at the Skokie Shop complex. The Chicago Transit Authority has had no new rail car maintenance facilities designed or constructed since the establishment of unit exchange maintenance procedures for rail vehicles at terminal locations in 1975.

The present role of terminal shops has changed to reflect the increasing complexity of the modern rapid transit car and its adaptability to unit exchange. This role is seen now as one of detection of faults and incipient failures, diagnosis of service failures, and repair of defects correctable by minor adjustment or by replacement of defective components and assemblies, lubrication,

and cleaning and washing. Additional functions will include minor modifications, retrofits, wheel grinding, and such, as necessary.

One of the reasons that CTA found itself able to adapt to unit exchange is the particular nature and history of Chicago rapid transit. CTA was proceeded by four separate companies, who joined forces to build the Chicago Union Loop Elevated in 1897. In so doing, they tied themselves together to eventually become one company. However, as four independent companies, they each had their own overhaul shop; Wilson and 61st Shops remain today. As such, these locations have always had some ability to do overhaul work and have had lifts and hoists which allowed the changeout of certain assemblies. These locations were never purely inspection facilities as they might be at other properties.

When CTA began to build newer maintenance facilities--such as when Congress replaced Laramie on the Garfield line--these facilities were replaced in kind. This process was repeated with Harlem and 98th. Having had this ability, CTA decided to use it to its advantage. Further, the classic idea of car overhaul required vehicles to be out of service for long periods of time. Additionally, there was no method to predict material usage. The development of an on-going overhaul has allowed the changeout of units on a pre-determined mileage basis.

When units are exchanged at the terminal, rather than Skokie, a car can be available for rush periods. Cars going to Skokie are generally lost from service for a few days; cars at the terminals can be returned to service more quickly.

Thus, with the ability to implement unit exchange at the terminals, CTA chose it as the most viable way to improve car availability and productivity. The Task Force has proceeded from there.

The goal of this element of the Yard Study is to set standards for rail maintenance buildings whereby the stated mission can be achieved. Some standards propose sharp departures from traditionally followed methods. For example, inspections have usually been conducted over pits. From Task Force investigation, it was decided to recommend fully equipped, hoisted positions for such operations. This is to easily accommodate unit exchange which soon will be done in multiples of inspections.

In each instance, careful consideration has been given to maximize productivity of labor and material resources. This criterion is evidenced in the stated preference for well-equipped relatively "small" shops with high production capacity, as opposed to larger shops with dedicated spaces or purchase of additional spare cars.

Though primarily a Task Force effort, it should be noted--as may well be expected--that the Maintenance Department was the major force in the preparation and recommendation of these standards. We present these for your approval.

GLOSSARY

Availability. The requirement that the equipment be available for and throughout peak use periods except when down for scheduled Planned Maintenance.

Bad Order (or Daily Defect). Equipment requiring repair work which may be conducted at a maintenance terminal.

Blowout. Air cleaning undercar assemblies. Blowout normally precedes inspection.

Blowout Pit. A pit located between the rails equipped with the suitable utilities to clean undercar assemblies.

Body (Exterior) Wash. An apparatus made up of brushes, spray arches, solution tanks, water reclamation system and controls to wash cars passing through the apparatus. The washer is fully automatic and should be located in the best possible work flow position. It is generally placed in a protective building.

Body Hoist. Apparatus, either electro-mechanical or hydraulic, usually used in conjunction with truck hoists, for maintaining a vehicle carbody in an elevated position. Often called body supports. Installation is part of shop track system.

Carbody. That portion of a car that carries people and all equipment except the truck assemblies.

Car (Interior) Wash. Washing of the inside car surfaces. Usually done manually.

Component. An essential part of an equipment. It is often used interchangeably with module or assembly.

Component Repair Shop. A facility specifically designed for repair, overhaul, and/or testing of electrical, mechanical, hydraulic, or pneumatic parts, modules, assemblies, or subsystems. It may be compared to a manufacturer's service repair shop. CTA component repair is conducted at Skokie Shop.

Consist. A train of more than one transit vehicle. See Maximum Consist.

Consist Change. The adding to or removal of cars from a train.

Design Standards. Guidelines which specify details and quantities for features outlined in the planning document.

Facility. A self-contained physical location housing a yard, a shop(s), or some combination thereof, with all necessary systems and equipment.

Heavy Repair. Changeout of trucks and other major assemblies and sub-assemblies, requiring power lifting equipment or several repairmen; major body repairs; rewiring.

Hoist. Apparatus, either electro-mechanical or hydraulic, generally used in conjunction with body hoists, for raising transit vehicles for inspection and repairs. Installation is part of shop track system. Sometimes called Truck Hoists.

Hoist Track. A track equipped with hoists.

Hostling Device. A mechanical device for moving cars prescribed distances at regular intervals of time. May be used in conjunction with wheel maintenance or exterior washing equipment.

Inspection. The checking for condition, performance, and safety of equipment against established standards, plus minor repairs and routine servicing.

Inspection Barn, see Maintenance Terminal.

Jacking Carriage. A movable lifting device supported on the flanges of pit track rails, used to raise trucks slightly off the rails so that the wheels can be spun under power to check traction motors and drive gear.

Layup. Removal of trains from service for storage in yard. May be performed by train crew or switchmen.

Light Repair. Repairs that can be performed on a pit track by one or two repairmen using hand tools and instruments only.

Main Shop. A transit facility specifically designed for heavy maintenance, overhaul, and testing of transit vehicles and equipment. Sometimes called Main Repair Shop; at CTA, Skokie Shops.

Maintenance. The upkeep of vehicles, plant, machinery, and equipment. It is normally scheduled, based on pre-established intervals of mileage and employing a pre-printed checklist, or it may be unscheduled or corrective, generally not interval based.

Maintenance Position, also Car Spot or Work Position. A one-car location in the Main Shop or Maintenance Terminal, either hoisted or pit, where maintenance work is performed. Since cars are normally paired with semipermanent coupling, there is usually an even number of maintenance positions along a shop track.

Maintenance of Way Department. That functional unit within a maintenance organization that generally has responsibility for track and structures.

Maintenance Terminal, also Service and Inspection Shop, Terminal Shop, or Shop. A transit facility responsible for Planned Maintenance and routine repair of daily defects. At CTA, located on each route.

Married Pair. Two cars that make up an operable transit vehicle unit, sharing certain equipments such as battery, control line, etc. A car of a married pair cannot function alone and the pair is connected with a semipermanent coupling which is not operationally separable.

Maximum Consist, Maximum Length Track. Refers to the length of the scheduled peak period train, normally 6 or 8 cars on CTA routes.

Mixed Equipment. A combination of several series of equipment of different ages and manufacture.

OSHA. Occupational Safety and Health Administration. A federal regulatory agency involved in all aspects of facilities that affect personnel safety and health.

Planned Maintenance. Maintenance work which is scheduled on the basis of pre-established intervals of mileage.

Planning Standard. Guidelines which establish general goals for facilities in terms of adequate operational capabilities and desired relationships between functional elements.

Pit. A depressed area below floor level mainly between running rails for undercar lubrication, inspection, and repair access, equipped with all necessary utilities.

Portable Car Jacks. Specifically designed jacks (usually in a set of four) for raising a single car. May be used anywhere at floor level where built-in jacks or hoists are not warranted or cannot be installed.

Putout. Placing cars from yard storage into service.

Retrofit. Modification of existing cars by addition or replacement of modules, assemblies, or parts.

Rolling Stock. A term generally referring to transit vehicles.

Service and Inspection. The activities of lubrication, inspection, and minor repairs associated with maintaining transit vehicles. Such activities are generally done in a Service and Inspection Shop at CTA, called a Maintenance Terminal.

Signal Department. The function within an engineering or maintenance organization responsible for the transit system's signals.

Shop Holding Track. A shop-accessible storage track adjacent to the building entrance, which permits exit of completed cars and queuing of subsequent cars to be served, thus,minimizing time lost by repairers waiting for work. See standard P-6.

Spinning Posts. Sets of four short columns used in conjunction with hoists to support a truck with wheels free to rotate when the hoist is lowered. Used to check traction motors and drive gear by spinning wheels under power. Usually unpowered, the posts are pivoted into position by hand and locked.

Stinger. An electrical device, usually on an overhead trolley, used for applying traction power to vehicles in a shop for testing of moving these vehicles. Some shops use external means of moving vehicles, such as trackmobiles or hostling devices.

Storage Yard. A facility containing a rail network for receiving, dispatching, and storing transit vehicles and work equipment.

Storeroom. An area used by Materials Management for storage of supply items.

Stockroom. An area used by Production/Supply Control to store items needed at the maintenance terminal.

Terminal Shop, see Maintenance Terminal.

Test Track. A length of track, usually separated from a main line, of sufficient length to safely operate a car or train through a performance cycle (start, accelerate, run at maximum speed, decelerate, stop). The track is equipped with all system safety features and with automatic train control.

Transportation Department. That functional unit within the organization that generally has responsibility for operation of cars, trains and stations, including a Control Center.

Truck. A major transit vehicle assembly of structural frame and suspension members, wheels, axles, motors, gearboxes, brakes, current collectors, cable, piping, etc.

Truck Hoist. See Hoist.

Truck Lift. Similar to garage auto lifts, usually hydraulic. Used to position separated car trucks at various elevations for repair access.

Truck Turntable. A device built into the track system for turning separated or disconnected trucks in a shop to facilitate transport between car work positions and other areas.

Trolley Block. Section of car underframe supporting current collection equipment.

Unit Changeout, Unit Exchange. Replacement of major components, assemblies, and modules, etc., with new or rebuilt.

Wing Pit Track. A pit track with depressed levels on either side of, as well as between suspended rails.

Wheel Grinding. Performed with a machine built into a shop track system for removing flat spots or metal build-up from wheel treads. May use grinding stones or belts. Very useful for relatively minor wheel work. Should be equipped with dust collection equipment.

Wheel Maintenance, see Wheel Grinding, Wheel Truing.

Wheel Spinning Jacks. Mechanical or hydraulic devices, built-in or portable, used for raising a wheel set or sets clear of running rail so wheels may be rotated under power. See Jacking Carriage.

Wheel Truing. Accomplished utilizing a machine for returning steel wheel profile to original contour; built into shop track system; may be a tracer lathe type or milling machine type. Should be equipped with chip collection and removal equipment.

Work Flow. The ordered sequence of work tasks required and their spatial arrangement in an enabling facility.

SIZE STANDARDS

PRODUCTIVITY STANDARDS

SUPPORT APPURTENANCES/ANCILLARY FACILITIES

ENVIRONMENTAL STANDARDS

SECTION I: BUILDING SIZE

One of the most complex issues in planning rail vehicle Maintenance buildings is ascertaining exactly how large a building should be. The thrust of this section, in fact this entire report, is to answer just that question.

The most easily understood common denominator for building size was found to be cars per space, or its arithmetic inverse, spaces per cars (X 100). (The inverse is simpler because a greater number of spaces is reflected by a larger number.)

On routes with single terminals, the entire assigned fleet will generally be maintained at one location (there are some exceptions). On routes with two or more terminals, unless otherwise determined, the cars assigned to that particular route will be maintained at all locations.

It should not be presumed that routes with several terminals will necessarily apportion maintenance equally. Equally distributed maintenance loads in some cases may be undesirable.

At CTA, cars are assigned on route basis; not on a yard or maintenance terminal basis. Hence, a car will be serviced at more than one terminal location if a route has more than one terminal (i.e., Lake-Dan Ryan has two terminals, Harlem and 98th; Ravenswood has one, Kimball). In application, the basis for determining shop sizes on a route will be the number of cars assigned to the route, and the mileage operated on the route.

In order to keep maintenance costs to a minimum, it is necessary to keep non-revenue car mileage to the minimum. This goal is most easily achieved when storage yards are sized and located in relation to operating schedules. However, since land available at terminals is limited, it may be necessary to construct maintenance buildings according to how well they fit after yard capacity requirements have been considered, thus creating some shops of only minimum acceptable size. This is practical because Planned Maintenance is programmed and layups may be scheduled to spot cars to terminals where the programmed work will be done. Thus on a multi-terminal route, it is conceivable that a "large" yard will have a "small" shop and vice versa. Of course, it is also possible that a "large" yard will have a "large" shop. What is important is to recognize is the possibility of variations. This highlights the importance of Yard Standard L-1, (draft schedule) which call for draft schedules to be made before site investigation. Planning and maintenance mandate that car mileage be determined in advance and properly accommodated.

SIZE STANDARDS

BUILDING SIZE DETERMINATION S-1

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Terminal shops for each route should, when taken together, provide 7.5 to 10 spaces per 100 cars.

DISCUSSION:

The Task Force developed this recommendation by taking the best elements of "workable" facilities at CTA and other properties and creating a formula around them.

CTA locations on routes with higher ratios had slack space which was used for sub-assembly or dedicated cab signal maintenance, see A-6 (cab signal maintenance). Shops with lower ratios were overcrowded.

Ratios for maintenance terminals (maintenance and inspection barns) at other properties and at CTA are shown on the next page. While these figures do not include heavy or overhaul type work such as performed at main shops, i.e., Skokie, it should be understood that no two properties were found to handle "terminal" maintenance work in quite the same way. In fact, CTA asks more of its terminal facilities in the way of work variety than almost any other transit property.

RELATED STANDARD

Building Standard A-6 (cab signal maintenance).

See example, Appendix to Section-P.

BUILDING SIZE DETERMINATION

S-1

Property/Route	Spaces per 100 cars
Philadelphia	
Broad St. SEPTA	14.4
Market - Frankfort SEPTA	11.4
Lindenwold (proposed) PATCO	8.0
Boston MBTA	
Red	36.6
Orange	72.0
Blue	45.0
Toronto TTC	
Bloor-Danforth (Greenwood)	15.9
*Yonge-Spadina (Davisville)	35.8
*Yonge-Spadina (Wilson)	18.7
Washington, D. C. (proposed S & I facility) WMATA	7.6
New York NYCTA **	
Chicago CTA	
West-South	7.1
West-Northwest	8.3
Ravenswood	3.4
North-South combined with Evanston, Skokie	13.8

* TTC assigns specific cars to each of their terminals for maintenance work.

** New York NYCTA is in the final stages of an economy program to reduce fleet size and close inspection facilities. It is not currently possible to determine their operating ratio.

MAINTENANCE TERMINAL LOCATION S-2

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Each maintenance terminal should be in an operating yard, with scheduled putouts and layups, in a location capable of supporting future expansion.

DISCUSSION:

A starting point in planning for car maintenance is producing a draft schedule for the line to be served by the maintenance terminals in order to forecast car mileage. A key advantage in Planned Maintenance is the ability for revenue service crews to drop off and pick up cars scheduled for Planned Maintenance. Maintenance terminals located in other than operating yards result in additional mileage costs produced by cars being transported to and from the maintenance location.

Changes in ridership over the years cannot always be predicted, and flexibility to enlarge or reduce maintenance capacity should be considered when building a new maintenance terminal.

RELATED STANDARDS:

Yard Standards: L-1 (draft schedule); L-2 (yard location on line); L-3 (adequate space); 0-4 (yard storage capacity).

SPACING BETWEEN HOIST TRACKS S-3

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Minimum distance between centers on hoist tracks will be 21 feet.

DISCUSSION:

Track centerline spacing of 21 feet between hoist-equipped tracks in existing CTA maintenance terminals has been found adequate for maintenance equipment movement and for hoisting equipment geometry.

RELATED STANDARDS:

Yard Standards: E-1 (storage track spacing); E-2 (track adjacent mainline).

See example, Appendix to Section-P.

SPACING BETWEEN WING PIT TRACKS S-4

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Minimum distance between centers on wing pit tracks will be 16 feet. Where there are building support columns or other obstructions, additional clearance will be required to safely pass cars and equpment. Minimum centerline spacing between hoist and pit tracks will be 21 feet.

DISCUSSION:

Shop equipment must be free to move between tracks. CTA experience has been that an unobstructed 16 feet is the minimum adequate centerline spacing between pit tracks, and 21 feet is the minimum between hoist and pit tracks.

RELATED STANDARDS:

Yard Standards: E-1 (storage track spacing); E-2 (track adjacent mainline).

See example, Appendix to Section-P.

TRACK GRADIENT

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Maintenance tracks terminal shall be level; a gradient of any magnitude is undesirable.

DISCUSSION:

Level maintenance building tracks are required for both safety and maintenance considerations.

CURVES IN BUILDINGS

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Curved tracks within buildings should be avoided.

DISCUSSION:

Curves require special consideration to avoid unusual structural design and clearances. Reduced visibility resulting from curves negatively impacts supervision and safety.

RELATED STANDARDS:

Yard Standards: O-5 (curved storage tracks).

STORAGE SPACE S-7

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Adequate parts storage to accomodate the numbers of cars assigned (refer to example at end of Size Section) and any anticipated mixed equipment and safe bulk storage of flammable liquids are required.

DISCUSSION:

Rail terminals must include space for stockroom, major unit storage, and staging and loading. Size requirements vary with the scale of operations. Stockroom area may be split at larger terminals if good access to delivery area is provided. For example, Desplaines stockroom is equipped with a hoist to lift material from one level to another. Smaller facilities should have a single stockroom located as close as possible to office and loading area.

Major unit storage should include track space for truck assembly and wheel assembly movement. For the staging and loading area, a traveling crane should be provided for loading and unloading material from delivery trucks. If a maintenance terminal is above ground, the opening between levels should be large enough to load and unload rail truck assemblies. A ten-ton capacity crane is necessary for unloading truck assemblies.

It must be noted that the example at the end of the Size Section states minima requirements. Provision for stockroom clerk(s) must be made in the stockroom area near the Foreman's office. Major unit storage must be separated from staging and loading area and space provided to allow free movement of hand trucks, forklifts, etc., and to allow repositioning of stored major unit items.

A flammable liquid storage room will be adequate to safely store lubricants and flammable liquids used at the terminal.

OTHER SPACE REQUIREMENTS S-8

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Provisions must be made to provide adequate space for lockers (including track work crews), washrooms, lunchrooms, classrooms/meeting area, office, and other employee facilities.

DISCUSSION:

Planning should consider requirements for employee conveniences. These facilities are important to employee morale and performance. Size guidelines for several shop sizes are suggested in the example at the end of this section.

RELATED STANDARDS:

Building Standard N-4 (employee facilities), same as Yard Standards E-22.

PAVING SHOP ENDS

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

At-grade areas adjacent to ends of maintenance terminals should be paved.

DISCUSSION:

At certain locations, paving will permit direct access to main floor by emergency, service, and delivery vehicles. Hostling devices, where applicable, could pick up defective cars outside shop and in holding area.

RELATED STANDARD:

Building Standard P-9 (road access).

MINIMUM BUILDING SIZE S-10

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

All maintenance terminals must be capable of supporting Planned Maintenance (see Related Standards), plus at least one maximum length train for daily defects.

DISCUSSION:

Fundamental levels of maintenance determine that a given shop should not be built below a given level of capability; this standard recognizes minimum capacity per Building Standard P-1 (terminal capacity). Building Standard A-1 (indoor car body washer) recommends at least one indoor car body washer per route; shops with these washers will be larger accordingly. Additionally, when multiple branch routes are considered together, each minimum terminal facility requirement can, when combined, produce routes with more than 10 spaces per 100 cars. Thus, route requirements may exceed a general rule of 7.5 to 10 maintenance positions per 100 cars.

RELATED STANDARDS:

Building Standards: S-1 (building size determination); P-1 (terminal capability); P-2 (preventive maintenance/unit exchange track); P-3 (maximum consist 'pit' track); P-7 (hoist positions); and A-1 (indoor car body washer).

SUPPORT SPATIAL REQUIREMENTS S-11

PRESENT STANDARD:

None stated.

RECOMMENDATION:

See table.

DISCUSSION:

Based on Task Force experience and the results of the "Bus Garage Standardization and Rehabilitation Study, " UMTA Project No. IT-09-0052 and IT-09-0072, the guidelines in the table which follows were developed. In addition to these requirements, site-specific dimensions must include provisions to accomodate switchmen, track crews, electricians, and other Maintenance personnel.

SPACE REQUIREMENTS
(square feet)

Operation	Capacity of facility A	B	C	D	E
lunchroom	600	1000	1500	1800	2100
washroom M/F 50/50	400/400	400/400	450/450	450/450	450/450
locker M/F 50/50	270/270	324/324	456/456	528/528	642/642
classroom/meeting room	600	600	600	600	600
office	450	450	500	500	500
stockroom	2000	3000	4000	5000	6000
major unit exchange storage	800	1200	1600	2000	2400
staging and loading	400	400	400	400	400

Where:

	Planned Maintenance unit exchange (paired) positions	daily defect repair max. consist tracks
A	2	1 or 2
B	3	2 or 3
C	4	3 or 4
D	5	4 or 5
E	6	5 or 6

SECTION II: PRODUCTIVITY

A major thrust of the Rail Car Maintenance Facility Study is to recommend buildings, configurations, and relationships that will improve labor and equipment productivity and help hold to a minimum the need for spare vehicles. Shop buildings must be accessible from the storage yard; lack of accessibility, as translated into time lost waiting for cars, is the major cause of lost productivity.

Shop positions must be flexible, each capable of supporting a variety of operations. Constructing "compact, well-equipped shops" requires multi-use locations. The smaller the site-specific shop, the greater emphasis on mechanized positions.

Separation of heavy and light work is a third recommendation for increasing productivity, which became apparent during the Task Force study. Introduction of the unit changeout program transformed the nature of the inspection interval from light to heavy repair and shifted the ideal location for inspections from pits to hoists. Changeouts performed during inspection interval make efficient use of shop equipment and manpower.

The optimum rail car shop incorporates both "short and wide" and "maximum length track" concepts. In effect, a shop building would have some tracks longer than others. This will leave capital intensive facilities accessible, while permitting Maintenance personnel to work on both maximum consist daily defects and planned maintenance programs.

In terms of increased labor productivity, the costs of fully-equipped, accessible, flexible maintenance terminals is low. Investment in equipment can greatly contribute to increased productivity. Assignment of manpower when vehicles are available should be considered as another possible way to maximize facility utilization; compatible operations could share facilities.

PRODUCTIVITY STANDARDS

TERMINAL CAPABILITY P-1

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

At a minimum, all terminals must be capable of handling planned maintenance and daily defects.

DISCUSSION:

Except for Main Rail Shop work, all planned maintenance will take place at the on-line maintenance terminals. Establishing flexible shops at all locations, rather than isolating certain activities, assures that required manpower and abilities will be available to handle maintenance needs wherever and whenever they occur. Planned maintenance programs are designed to minimize service dealys and extend the life cycles of car equipment. When daily defects occur they need to be corrected in the most efficient manner as soon as practical to maintain vehicle availability for revenue service. This helps to hold spare cars to a minimum.

PLANNED MAINTENANCE/UNIT EXCHANGE TRACK

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

A combination of truck hoists with spinning posts and body hoists with turntables should be installed on every hoist track.

DISCUSSION:

The above equipment provides the maximum capabilities per hoisted location. Harlem and 98th shops, although limited by yard accessibility, were found to be relatively successful because each has two or more individually accessible two-car work positions, each equipped with partial hoisting capability. Once hoisted, a unit may have several kinds of work done more quickly than being repositioned from track to track, particularly the change-out of large and/or heavy assemblies.

See example, Appendix to this section.

MAXIMUM CONSIST (PIT) TRACK

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Each terminal shop should have at least one maximum consist length (pit) track.

DISCUSSION:

Both car and overall labor productivity will be increased by reducing the need to cut and add cars which are to be spotted inside the shop.

1. The labor required to couple and uncouple cars that need minor trouble-shooting and repair will be completely avoided.

2. Yard movements to bring a train into the shop are simplified, making access to the building much easier.

The faster the overall process is accomplished, the fewer cars will be held out of service during peak periods and, hence, the fewer backup cars will be needed.

Additionally, there are certain types of bad orders which require repair without uncoupling, because defects are of an intermittent nature or would disappear if uncoupled, and these must be repaired on a maximum consist length track. This work now occurs outdoors, exposed to the worst of weather. With a maximum length track, the work will be moved indoors.

See example, Appendix to this section.

MULTI-USE OF TRACKS P-4

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

All positions in shops must be multi-purpose, capable of supporting several operations.

DISCUSSION:

Maximum utility from capital investment dictates flexible facilities. Ideally, shop positions should have both a primary and a secondary use. Compatible combinations of washer, inspection, wheel maintenance, blowout, and trouble tracks improve equipment productivity. Multi-use of tracks will afford the Authority versatility in responding to emergency conditions.

RELATED STANDARD:

Building Standard A-5 (cab signal maintenance).

ACCESSIBILITY -- DOUBLE-ENDED SHOP P-5

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Holding tracks of capacity equal to the length of the shop track, ideally on both ends, should be directly accessible to the shop and storage yard, (i.e., track connections should not cross mainline or turnback tracks).

DISCUSSION:

Such a layout affords production line flow and reduces non-productivity of repairers waiting for cars.

RELATED STANDARDS:

Yard Standards: O-8 (access from storage); O-9 (holding areas).

ACCESSIBILITY -- SINGLE ENDED SHOP

PRESENT STANDARD:

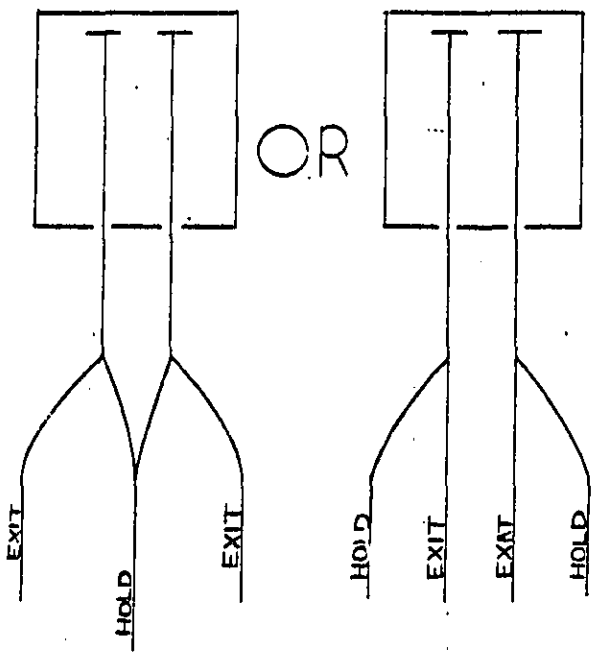
None stated.

RECOMMENDED STANDARD:

A second track, in addition to the holding track, should be provided for single-ended shop tracks (see illustration).

DISCUSSION:

As noted in the Introduction, shop accessibility is essential to shop productivity. An alternate route to a single-ended shop position allows release of repaired cars, quick entry to vacant positions, and time to prestage cars awaiting repair, thus maximizing equipment usage and minimizing non-productive time.



RELATED STANDARDS:

Yard Standards: 0-9 (holding areas).

HOIST POSITIONS

PRESENT STANDARDS:

None stated.

RECOMMENDED STANDARD:

Hoisted positions should not be longer than four cars. Four-car positions must be double-ended. Two-car hoisted positions may be single-ended.

DISCUSSION:

Accessibility is provided by double-ending a four-car track. If one set of hoists were in use, cars on the other set of hoists could be released for service from the other end.

RELATED STANDARDS:

Yard Standard: 0-6 (double-ended yards).

CAR MOVEMENTS WITHIN SHOP P-8

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Hostling devices should be considered for movement of cars within shop in site specific conditions where cost effectiveness and increased labor productivity would result.

DISCUSSION:

Site-specific investigation of car movers and their potential labor savings is warranted. Operations which require several persons or which require switching over an extended period of time could be made more efficient with the employment of hostlers. Car movers would also yield improved safety conditions with the limited use of stingers.

It is anticipated that, depending on design, some sort of hostling device will be used in conjunction with the blowout and wheel repair functions.

RELATED STANDARDS:

Building Standards: A-3 (car blowout); A-4 (wheel maintenance); S-15 (paving shop ends).

ROAD ACCESS P-9

PRESENT STANDARD:

None stated:

RECOMMENDED STANDARD:

All shops must be directly accessible by motor vehicles.

DISCUSSION:

Direct road vehicle access is absolutely essential for security and fire protection, and for shipments to supply Production/Supply Control. Motor truck delivery of all unit exchange assemblies should be provided for.

RELATED STANDARDS:

Yard Standard: L-4 (road vehicle access).

COMPREHENSIVE EXAMPLE

The table which follows illustrates how standards may be applied to determine space requirements. For planning on a given route, schedules must be prepared (Yard Standard L-1, Building Standard S-2). These draft schedules are used to estimate the number of cars needed for service, which in turn specifies yard size (L-3) and the number of maintenance positions required in the shop (S-1).

Positions are further described in terms of productivity. Building Standards call for Planned Maintenance/unit exchange tracks equipped with hoists (P-2) and for at least one maximum length consist pit track per terminal shop for repair of daily defects (P-3).

Considering track spacing (S-3 and S-4) and car length (48 feet), building sizes may be developed. Equipment (A-section) and employee facilities and environment (N-section) must then be provided.

EXAMPLE: Bedrock Route

A. Given: Bedrock schedule requires 100 cars

B. Building Standard S-1 recommends 7.5 to 10 maintenance positions per 100 cars. Bedrock should have 7.5 to 10 positions.

C. Building Standard P-2 recommends hoisted positions for Planned Maintenance/unit exchange. Bedrock would have one two-car track for a hoisted pair.

D. Building Standard P-3 recommends at least one maximum length track for daily defect repair. Bedrock typically runs 8-car trains. So its maintenance terminal would have at least one 8-car pit track. An indoor washer might be additional.*

Thus far we have:

max. length track	= 8 positions
hoisted pair track	= 2 positions
	10 positions

This compares with standard S-1 in B.

E. Building Standard S-4 defines the space between the hoist and pit tracks as 21 feet. The distance between tracks and walls is also 21 feet.

The minimum building size may now be estimated as follows:

length 8 cars x 48 ft./car	= 384 feet.
width 3 spaces x 21 ft./space	= 63 feet.

Or, approximately 65 x 400 feet. The above might not allow for an indoor washer* (see A-1) or other equipment which may require additional area. On routes with more than one maintenance terminal, space will be divided among them, although all shops will be able to support a minimum level of maintenance (see S-10).

*Whether or not an additional track is needed for an indoor car washer or whether it can be combined with the maximum length pit track depends on the operating schedule of the route. This is site-specific and is part of the required terminal planning analysis work.

SECTION III: SUPPORT APPURTENANCES/ANCILLARY FACILITIES

This section describes support equipment needed for normal operations, and facilities required for optimal performance. Some items in the standards which follow provide solutions to problems which have existed for many years, such as an indoor car body washer. Other items are more ubiquitous, although no specific guidelines have been established for their use. In these instances, standards are suggested for future design and upgrading. "One compressed air outlet per car position," is an example, rather than arbitrary numbers which may now exist.

Experience indicates minimum amounts of routine equipment and facilities needed to maintain service. Where new procedures and tools are introduced, the Task Force based its recommendations on observations and experience at certain CTA terminals and at other transit properties in a hoped-for optimum combination.

In the case of cab signal repairs, we maximize the use of facilities by doing general vehicle and cab signal repairs at the same shop position at different times of day. This is possible because of the different nature of vehicle and cab signal repairs. A bad order cab signal can be run in more than minimum length trains by being spotted in between good cars and are thus available in rush periods. General vehicle defects are usually non-operable cars and must be repaired as soon as practical, to make cars available for peak hour service.

SUPPORT APPURTENANCES/ANCILLARY FACILITIES

INDOOR CAR BODY WASHER A-1

PRESENT STANDARD:

None.

RECOMMENDED STANDARD:

Each route must be equipped with at least one indoor car body washer, capable of washing trains of maximum consist length.

DISCUSSION:

Each route must have all-weather car washing capability. Winter-related problems make washing essential: ice and snow build up; salt accumulates and shorts trolley blocks. At least one indoor washer for car exterior cleaning must be available on each route; outside washing equipment will be available at other locations.

The washer should be on a maximum consist track, which also provides pre-wash and associated drying appurtenances needed to prevent cars from freezing in cold weather. It may share facilities with operations requiring a pit track.

RELATED STANDARD:

Building Standard S-2 (minimum building size).

CAR INTERIOR CLEANING AND WASHING

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Well-equipped, semi-dedicated facilities should be provided for car interior cleaning and washing at each terminal where planned maintenance is done.

DISCUSSION:

Extensive cleaning and washing of car interiors is scheduled with each unit's current Planned Maintenance inspection. Tracks specially equipped with heated water, central vacuum lines, and 208/120 AC power should be provided both on an indoor track and on an outdoor track immediately adjacent to the building. Weather permitting, the outdoor location is preferred as it will provide added flexibility and increase in uses for the interior location. Because units with sealed windows require air comfort for proper ventilation, the outdoor location—which supplies immediate contact with 600 V. DC power—is more convenient in favorable weather, since no special power connection is needed. Both tracks may be shared with other functions.

CAR BLOWOUT

PRESENT STANDARD:

Only some terminals have blowout.

RECOMMENDED STANDARD:

Facilities should be provided for car blowout at all terminals that conduct inspections.

DISCUSSION:

Cars are normally blown out with compressed air to remove dust from motors and electrical contacts prior to inspection. A specially ventilated area should be provided with compressed air to dislodge dirt and vacuum to capture it, and which can be enclosed during blowout. The area should be of sufficient length to enable a two-car unit to be completed without opening the enclosure. Wheel maintenance, another dusty operation, may also be accomodated in this enclosure; opened up, the track may be used as a pit. Car hostling equipment should be available to move the cars during blowout.

WHEEL MAINTENANCE A-4

None stated.

RECOMMENDED STANDARD:

Provision for wheel maintenance should be made on each route.

DISCUSSION:

Allowance should be made for future wheel honing/grinding/truing equipment. The type will be selected after experience has been had with the Hegenscheidt at Skokie and will be geared to the character and service of the particular route to be served.

CAB SIGNAL MAINTENANCE A-5

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Cab signal inspection/repair should be performed in a shared shop position, and may be done at night.

DISCUSSION:

Cab signal inspection should be conducted simultaneously with current planned maintenance. This allows maintenance to be performed as required, minimizes the number of in-service failures, and reduces the amount of times a car is removed from service, and hence, helps hold to a minimum the number of cars in the fleet.

Although track space is shared, it is essential that separate bench, storage, and administrative areas be allocated exclusively to cab signal maintenance. This work has highly specialized needs, which cannot function without this dedicated space.

RELATED STANDARDS:

Yard Standards: O-11 (cab signal test track); O-12 (cab signal static test). Building Standard S-1 (building size determination).

SECURITY

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

In the construction of new facilities as well as renovating of existing facilities, physical security controls should be included as an essential element in the architectural design.

DISCUSSION:

The primary goal of security engineering is to decrease loss and increase safe and effective utilization of the area. Security requirements should consider and incorporate in their design three successive barriers to penetration where possible:

--perimeter and structure relationship (such as fencing, lights, landscaping, and natural barriers),

--exterior building perimeter (on doors, windows, walls, vents, etc.), and

--interior security and sensitive area location.

In addition to anti-intrusion features, security engineering will also include access control through means of perimeter and interior control design. Access control will restrain the movement of employees, visitors, etc., both inside and outside the facilities. In this way, traffic flows can be patterned for safe, efficient movement and at the same time reduce the opportunity for theft and other criminal acts. For example, employees' parking should be arranged to be not only convenient to work areas, but also supervised at entry points. This reduces the possibility of loss to both employees and the Authority.

RELATED STANDARD:

Same as Yard Standard E-23 (security).

OUTDOOR WEATHER PROTECTION A-7

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Weather protection should be installed where it is necessary to perform light maintenance in the yard.

DISCUSSION:

Train service must be maintained under all weather conditions. Indoor facilities will be provided for all normal maintenance operations. However, it may be necessary or desirable to perform certain functions outside. Protection from weather, possibly including heat in winter, must be provided.

RELATED STANDARD:

Yard Standards: E-20 (cut and add facilities).

ADMINISTRATIVE AND SUPERVISORY COMMUNICATIONS A-8

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Means of transmitting and receiving vehicle maintenance data from other maintenance locations and of carrying voice communications between the office and locations throughout the facility should be provided at each maintenance terminal.

DISCUSSION:

In addition to telephone service, convenient space and adequate wiring connections are needed to accommodate electronic data processing and/or transmitting and receiving equipment, such as the RVMS (Rail Vehicle Maintenance System). Such systems keep maintenance records up to date automatically, and allow quick access to needed information. A properly arranged paging/intercom system is needed to enable adequate supervision to be sought and received in all areas of the facility.

MATRIX

DISCUSSION:

Activities at CTA Maintenance Terminals are normally limited to inspection, unit changeout, trouble diagnosis, minor repairs, and cleaning and washing.

Inspection includes the following:

1. Preparation -- Cars are brought into the building. In freezing weather, ice and snow on the cars is melted and drained away. Motors and control housings are opened, and dust and dirt are blown out with compressed air.

2. Controls -- All components of the propulsion and braking control system, including the motor generator/motor alternator or static converter and inverter are checked and tested, and cleaned and adjusted as necessary. Defective or worn parts are replaced, and defective major units (excluding control groups) are changed out.

3. Trucks -- Traction motors and motor leads are checked, and worn commutator brushes replaced. The condition of drive shafts and friction brakes is checked. Motor bearings and axle gearing are checked by raising the trucks off the rails and spinning the wheels. Defects are corrected by adjustment, part replacement, and unit changeout.

4. Lubrication -- Trolley pickup and truck chassis components are greased and mechanical couplers cleaned and greased. Axle bearing oil is checked and added or changed as needed.

5. Air Conditioner -- Compressors, blowers, condensers and evaporators are checked, and lost refrigerant gas is replaced. Air filters are reconditioned or replaced, depending on type. Thermostats are checked and replaced as required.

6. Car body -- Horn, headlight, and marker lights are checked. All interior controls are cleaned, checked, and repaired or replaced, as needed. Body lights, windows, doors, seats, and stanchions are checked and repaired as needed. Batteries are cleaned and tested, and lost water replaced.

7. Cab signal equipment -- All functions are tested and defects found are correct by adjustment and replacing defective parts and modules.

Unit changeout includes removing and replacing the following major assemblies and subassemblies:

1. Trucks and truck-mounted units, including entire trucks, axles, traction motors, friction brakes and brake actuators, track brakes, side trips, suspension springs and shock absorbers, trolley beams, and current collection equipment.

2. Other major units, including motor generators and motor alternators, static converters, static inverters, air conditioner compressors, blowers, motor shunt resistor assemblies, accelerators, line breakers, reversers, drawbars, and drum switches. At this time, control groups are changed out only at Skokie Shops.

Trouble Diagnosis is mainly circuit checking to pinpoint the causes of malfunctions in the propulsion system and controls of a car.

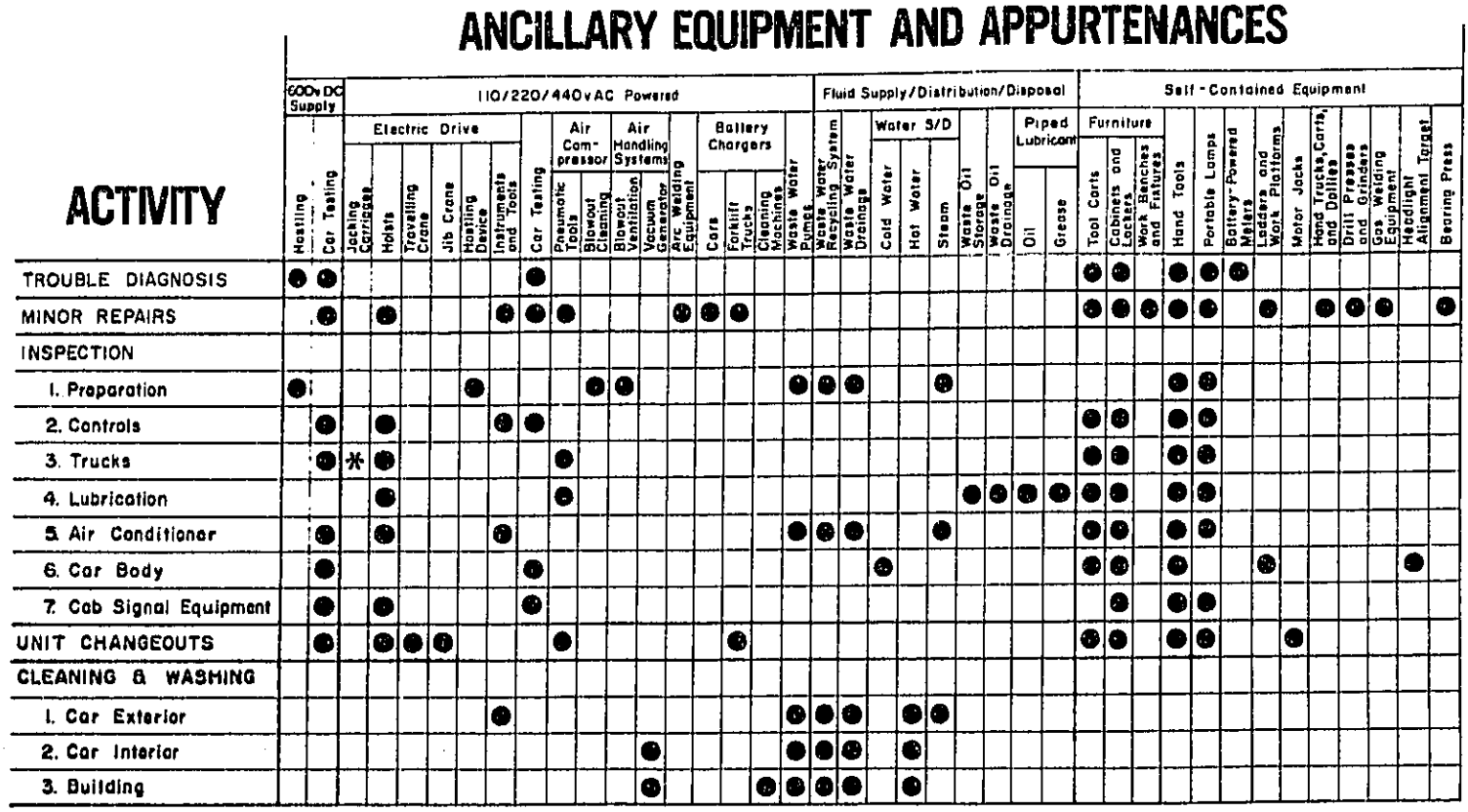
Minor Repairs include the following:

1. Replacing damaged items such as window and door glass, seat cushions, lamps, fasteners, and electrical parts.
2. Minor body or structural defects are repaired.
3. Charging batteries, adjusting door mechanisms and other mechanical devices, and adjusting and calibrating electrical/electronic devices.

Cleaning and Washing includes frequent washing of car body exteriors, daily cleaning of car interiors, periodic washing of interiors, and daily cleaning of the terminal maintenance building.

These activities should be supported at each terminal maintenance building by the facilities shown on the following table.

ANCILLARY EQUIPMENT AND APPURTENANCES



* - Backup equipment, enabling inspections on pit tracks when hoists are not available

SECTION IV: ENVIRONMENT

Thus far, this report has covered maintenance terminals planning goals relating to physical and equipment considerations. Human factors also play an important role, since high employee morale translates into better performance. In this section, standards for general working conditions are given.

It could almost go unsaid that any environmental impacts (e.g., visual, noise, vibration, air) must comply with standards set by Federal, state and local governments. CTA's high visibility prescribes that maximum emphasis be placed on environmental issues, including pollution reduction and energy conservation.

CTA generally subscribes to all applicable code regulations as required. When several codes exist, CTA tends to abide by the most restrictive.

ENVIRONMENTAL STANDARDS

ENERGY CONSERVATION N-1

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Shop heating and illumination should be an application of the latest technology, in an optimum balance between artificial and natural, to produce an energy efficient building.

DISCUSSION:

Proper lighting and heating/ventilation are required to maintain productivity. Natural light may supplement artificial light where windows are designed to forestall heat loss. Good insulation impedes conductive building shell losses and reduces the transmissive-time effects of radiative heat gains. Buildings require insulation to reduce winter heat loss and summer heat gain.

WORKING SOUND LEVEL N-2

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

All new machinery, intended for fixed, stationary use, should not exceed a sound level of 85 dBA, measured at the operator's position.

DISCUSSION:

Any machinery purchased for use on CTA property should conform to the 85 dBA goal set by OSHA and the Environmental Protection Agency.

RELATED STANDARD:

Yard Standard: L-5 (environmental impacts).

WALKING DISTANCES N-3

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Routes for circulation within work areas should be predesigned to hold walking to a minimum.

DISCUSSION:

Employee facilities, support equipment and facilities, and work areas should be located to provide safe, direct, and unencumbered travel. Workflows and paths should be planned to allow short, point-to-point routes and to prevent possibly unsafe short cuts.

RELATED STANDARD:

Building Standards: N-8 (safe walking surface).

EMPLOYEE FACILITIES N-4

PRESENT STANDARD:

None stated.

RECOMMENDED STANDARD:

Employee facilities should be as compact as possible and located close to but separated from work areas.

DISCUSSION:

Consolidation of facilities, e. g., toilet, locker, lunch, and rest areas, maximizes capital return; attractive facilities improve morale. It is advised that toilet and lunch areas be separated from each other and from work areas, and that, where possible, facilities should be on the same level with work areas.

RELATED STANDARDS:

Building Standards: N-3 (walking distances); Yard Standards: same as E-22 (employee facilities).

SAFE CLEARANCE N-5

PRESENT STANDARD:

None specifically for maintenance terminals.

RECOMMENDED STANDARD:

Maintenance terminal planning must allow safe clearances for employees.

DISCUSSION:

Care must be given in planning maintenance terminals to provide adequate clearances for personnel. Ample space between cars and door frames and structural columns are particularly important. Experience shows that a place where there is "almost" enough room can be potentially more dangerous than a place where there is obviously not enough clearance.

Although no prior standard exists for maintenance buildings, borrowing from subway tube standards suggests 14' 4" as a suitable overhead door width for rail car entry.

600 V. DC CUTOFF N-6

PRESENT STANDARD:

None for maintenance terminals.

RECOMMENDED STANDARD:

Emergency power cutoffs in maintenance terminal shall be strategically placed to insure that travel distance from work locations will not exceed 50 feet nominally.

DISCUSSION:

Quick removal of power can be vital to employee safety.

RELATED STANDARDS:

Yard Standards: E-14 (control); E-17 (traction power cutoff).