AMTRAK®

Infrastructure Appx. B

Asset Strategies

Historic Opportunities | Amtrak's FY 2022-2027 Service and Asset Line Plans

Appendix B: Asset Strategies

Appendix B provides additional information on Amtrak's lifecycle management strategies to achieve a state of good repair (SOGR).

Current Asset Strategies

As detailed in the main document, Amtrak has existing strategies for ensuring safe operation of the infrastructure and for the trains passing over it. The specific details for each technical discipline are presented in the tables contained herein.

The existing strategies are centered around these core activities:

- *Inspection/ monitoring* activities to confirm the asset can function in its required state and provide a safe operational environment.
- *Preventive maintenance* activities to achieve a required level of asset performance and maintain a safe operational environment.
- *Corrective maintenance* activities to return the asset to its required function and restore a safe operational environment.
- *Capital maintenance* to restore the asset to an operational design standard and maintain performance.
- *Capital replacement* to renew the asset and maintain performance.
- *Capital improvement* to replace the asset and improve performance or network capability.

Current Asset Strategies - Track

Category	Description
Inspection/ Monitoring	Inspections and monitoring activities to identify defects before failure. These include: → Track Geometry Car → Sperry Ultrasonic Rail Inspection Car (internal rail defect identification) → Gage Restraint Measurement → Monitoring Systems on Acela (ARMS) → Track walk/high rail visual inspections → GPR inspection of Track bed (sub-grade) conducted every 5 years → Automated Wood tie inspection system Other remote condition monitoring systems used to detect detrimental wheel/rail interface issues include: → Wheel Impact Load Detectors (WILDs) → Lateral Load Devices (used to manage detrimental bi-level train wheel/rail interaction at New England locations) → Rail temperature monitoring to intervene with operating restrictions to protect track against buckling/pull-apart

Preventive Maintenance	Preventive maintenance activities to achieve the asset useful life benchmark in its current operational environment (load, speed etc.) – this includes rail lubrication, spot repairs to the fastening system (ties, clips, etc.). Preventive maintenance to prepare for seasonal changes to maintain minimum operation standards is defined in MW 1000.
Corrective Maintenance	Unplanned maintenance following identification of all defects and failures to return track to minimum operation standards per MW 1000 standard. Planned corrective maintenance to remove other defects based on risk and install permanent solutions where appropriate.
Capital Maintenance	Capital maintenance to restore track structure to operational design standard – as defined in both the FRA standard and MW 1000 standard. This includes: → Surfacing and lining operations to restore track geometry design → Undercutting to improve ballast quality and restore track geometry design → Rail grinding to restore the railhead profile, remove rail corrugation and reduce rail deterioration
Capital Replacement	Replacement in whole or part of the track structure, to restore design capability of the asset when it no longer becomes cost effective to maintain or presents an unacceptable safety or operational risk. Factors considered: defect rate, wear, and age.
Capital Improvement	Replacement in whole or part of the track structure, to improve the capability of the track infrastructure. Improvement includes increases to track class resulting in ability to operate at higher speeds and improvements to track layout to improve network capacity/on time performance.

Current Asset Strategies - Structures

Category	Description
Bridges	
Inspection/ Monitoring	→ Annual Bridge inspections utilizing a 0-6 scale, identify defects or potential defects at a component level and are used to drive the capital plan. → Comprehensive follow-up and monitoring of all bridges rated at 6, 5 and 4. Inspection programs designed for each asset. → Monthly and quarterly program of comprehensive inspections of all movable bridge components. → Monthly and quarterly inspection of all movable bridges over waterways. → Special inspections following bridge movements (movable bridges) or flood events. → Real time monitoring of critical bridges, including load, vibrations, movement etc.
Preventive Maintenance	→ Preventive maintenance undertaken as per Amtrak bridge maintenance management manuals.
Capital Maintenance	→ Significant level of capital maintenance undertaken on bridges to maintain the asset in service. Generally accomplished through selective component replacement to maintain safe operation.
Capital Replacement	→ Capital replacement strategies as detailed below.
Capital Improvement	→ Capital improvement strategies as detailed below.

Facilities	
Inspection/ Monitoring	→ Building inspections are scheduled every 5 years utilizing a "Good" to "Very Poor" scale to assess the integrity of the SOGR of the site, building envelop and asset systems and to verify compliance with local codes. → Each building system category is assessed based on overall appearance and condition, and its equipment/components rated accordingly. → A priority scale is used to access each component (rates life safety, SOGR, efficiency, and others). → Comprehensive follow-up for poorly rated buildings / building systems. → Engineering is notified of conditions requiring immediate attention.
Preventive Maintenance	→ Preventive maintenance undertaken as per Amtrak building maintenance management manuals.
Capital Maintenance	→ Provided for building systems to maintain assets in service. Generally accomplished through a selective process based on the results of building inspections and findings during maintenance procedures. Assets are proposed based on SOGR inspections and selected based on their criticality, such as safety, customer service, regulatory or code compliance.
Capital Replacement	→ Capital replacement is provided for building systems to replace assets which are no longer in SOGR. Generally accomplished through a selective replacement process, assets are proposed based on the results of building inspections or maintenance conclusions and are selected based on criticality such as safety, customer service, and regulatory or code compliance.
Capital Improvement	→ Capital improvement is provided for building systems to replace assets which are either no longer in SOGR or "outdated" and not in compliance with present standards or codes. Generally accomplished through a selective improvement process, assets are proposed based on the results of building inspections and/or compliance and selected based on criticality such as safety, customer service, and regulatory or code compliance.

Current Asset Strategies – Electric Traction

Category	Description
Catenary Lines/ Structures	
Inspection/ Monitoring	→ Automated inspections by catenary geometry car. → Visual inspections by engineers in catenary maintenance car and on foot. → Visual assessment of catenary structures by helicopter.
Preventive Maintenance	→ Spot repairs to components identified as defects from various inspections. → Corrosion treatment and painting of catenary structures (limited use due to resource constraints). → Installation of barriers, isolating devices, and/or treatment surfaces at overhead bridges to reduce the negative effects of ice and wildlife.
Capital Replacement	→ Corrective maintenance of failed components treated as capital replacement. → Limited replacement of catenary structures – based on failed or high risk of failure. → Limited replacement of catenary/transmission lines – based on failed or high risk of failure. Cat wire replacement is based on wear measurements from CGC and Cat inspection car.
Capital Improvement	→ Limited modernization of overhead catenary wires to constant tension along a 23-mile section of track in New Jersey to accommodate operating at speeds up to 160 mph and increase reliability. → Replacement of outdated constant tension components in New England Division with newer versions that are more reliable.

Substations/ Feeder Stations	
Inspection/ Monitoring	→ Monthly visual safety inspection. → Visual assessment of all asset conditions.
Preventive Maintenance	→ Preventative maintenance to all substation components as described in the ET Substation Inspection and Maintenance Manual
Capital Replacement	→ Focused on transformers, breakers, and switches – to reduce risk of failure. → Control houses to be replaced in kind and cut over programmatically.
Capital Improvement	→ Replacement of Rotary Signal Power Machines with more reliable and modern static models → Upgrade to the current SCADA system.

Current Asset Strategies – Communications & Signals

Category	Description
Inspection/ Monitoring	→ Signals – federally mandated inspections as detailed in AMT-27 are always completed. → Communications – Amtrak-specified regular inspection program.
Preventive Maintenance	→ Preventive maintenance is limited due to available, qualified resources. AMT-23[1] establishes standards for asset general maintenance.
Corrective Maintenance	→ Focus is on corrective maintenance to ensure safe operations – correcting faults and issues identified in the AMT-27 standard.
Capital Maintenance	→ Capital maintenance (rehabilitation) includes spot replacement of instrument house components (microprocessors, battery track circuits, etc.).
Capital Replacement	→ Replacement of right-of-way infrastructure, more often driven by Track capital program. → Targeted replacement to remove air switch machines and replace with electric switches, again driven by the track capital program (opportunity). → Targeted renewal of 1 ABS location and 1 Interlocking per division per year.
Capital Improvement	→ Major system upgrades to improve capacity and introduce more modern technology includes: o Complete interlocking replacements of instrument house. o ABS upgrades driven by enhancement (e.g., New Jersey high speed). o Advance NORAC Rule 562 Cab-No Wayside signaling to reduce maintenance costs and increase train capacity, OTP, and allowable speed.

[1] AMTRAK AMT-23, "*Special Instructions Governing Construction and Maintenance of Signals and Interlockings.”*- Rev 4 Date August 1st 2006.

Moving Towards Normalized or Steady State Maintenance

Lifecycle Management Strategies Overview

With the development of the 2017 Northeast Corridor Asset Management Plan, Amtrak Engineering commenced a review of the lifecycle management strategies for all infrastructure assets to develop the long-term infrastructure maintenance and improvement programs to reach SOGR. There are four key elements to the Amtrak's lifecycle management strategies, namely:

Achieve SOGR	The primary objective of this strategy is to bring the infrastructure assets to a state of good repair and then maintain them in a steady state to ensure sufficient capability to meet operational needs.
Prevent Insidious Decline	While Amtrak progresses towards SOGR, introduction of an enhanced assessment regime will guard against the insidious decline in the condition of any individual assets and ensure that they remain in a safe operational state.
Maintain Performance	The implementation of the steady state strategy is through a program that is prioritized to ensure that the infrastructure assets can function in their required state, thus minimizing performance loss due to asset faults and failures.
Support Network Capability Improvement	The program is also designed to ensure that the infrastructure assets contribute to capability targets established through the Amtrak Service Plans, including enabling higher speed operations.

The lifecycle management strategies for each technical discipline are presented in the following tables.

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To prevent insidious decline of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To prevent insidious decline of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Corrective Maintenance		
General	→ To prevent insidious decline and maintain operational performance of track assets, continue to perform activities based on FRA and MW 1000 standard.	→ No significant change to current practice.
Capital Maintenance		
Surfacing	**Track class 1-5:** → No cyclical program of surfacing. **Track class 6-8:** → To maintain operational performance and support network capability, undertake track surfacing on a 3-4 year cycle as a preventive maintenance activity.	→ Cyclical track surfacing is driven by analysis of data collected from track geometry car. A program of increased reference surfacing will be developed through this plan period. Increased work volume will require procurement of additional high-speed surfacing equipment.
Undercutting	→ To achieve SOGR and maintain operational performance and prevent insidious decline, rehabilitate ballast through undercutting performed every 15-18 years. → In locations where out of face undercutting is not performed. A surfacing cycle every 5 years with spot undercutting is used to maintain operational performance. This applies to sidings, yards, and National Network locations.	→ A program of increased undercutting will be developed through this plan period. Increased work volume will require procurement of additional undercutting equipment. Analysis of gang consists and schedules to increase productivity is also underway.

Rail Grinding	**Track Class 6-8:** → To maintain operational performance and prevent insidious decline, undertake a program of rail grinding on a 5-year cycle.	→ To achieve extension of life benefits, the Track Department has developed a rail grinding program for this plan period based on the 5-year cycle.
Capital Replacement		
The NEC mainline is the busiest railroad in North America. Scheduled frequencies are fluctuating with demand and COVID-19 pandemic conditions, which will result in a decreased or inconsistent opportunity to do track work on the main line. Track access is therefore a significant constraint to implementing the lifecycle management strategies below. With that in mind, an amended *work package* strategy is proposed that makes more efficient use of track access. This includes the following strategies: → The replacement of the entire track system if more than two primary assets (rail, ties, or ballast) are within 10 years of their useful life benchmark. → Extension of the length of planned track system renewal should other sections within the vicinity be within 10 years of their useful life benchmark. → Improve coordination with Communications and Signals by upgrading symbiotic components simultaneously, such as head timbers or turnout renewals with switch machine and other devices. This will ensure that multiple track occupancies are avoided.		
Concrete Ties	**Track class 1-4:** → To achieve SOGR and maintain operational performance, concrete ties plan to be replaced every 60 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. **Track class 5-8:** → To achieve SOGR and maintain operational performance, concrete ties will be replaced every 45 years on all tangent running rail in track class 5-8. → To achieve SOGR and maintain operational performance, concrete ties will be replaced every 45 years on all curved running rail in track class 5-8. → To maintain operational performance, defective Rocla concrete ties will be replaced as part of an on-going effort based on conditions found during track inspections.	**Track class 1-4:** → A program of concrete tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. **Track class 5-8:** → A program of concrete tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → For efficient use of track access, replacement of concrete ties will coincide with rail renewal if rails are life expired within 10 years of planned work.

Wood Ties	**Track class 1-4:** → To achieve SOGR and maintain operational performance, wood ties will be replaced every 35 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. **Track class 5,6:** → Our general strategy is to replace wood ties with concrete ties where economical to do so on higher class lines. → To achieve SOGR and maintain operational performance, wood ties will be replaced every 30 years on all corridor running rail in track class 5-6, depending on traffic usage and track class. → To improve network performance, it is our desire to replace wood ties with concrete ties on corridor at the earliest cost-effective opportunity. **Track class 7,8:** → No wood ties remaining.	**Track class 1-4:** → A program of wood tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → Note: Typical production delivery, replaces every 3rd tie only. As a result, each location should be visited 4 times in a 35-year period (roughly every 8 years) **Track class 5-6:** → A program of wood tie replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. → For efficient use of track access, replacement of wood ties with concrete will coincide with either ballast renewal or rail renewal if either are life expired within 10 years of planned work. → Note: Typical production delivery, replaces every 3rd tie only. As a result, each location should be visited 3 times in a 30-year period (roughly every 8 years).
Fastening System	→ To achieve SOGR and maintain operational performance, the fastening system will be replaced at the same frequency as undercutting operations.	→ Fastening system replacement occurs simultaneously with undercutting operations.
Rail	**Track class 1-4:** → To achieve SOGR and maintain operational performance, rail will be replaced every 60 years on all off corridor running rail in track class 1-4, depending on traffic usage and track class. → To achieve SOGR and maintain operational performance, rail will be replaced every 55 years on all curved running rail in track class 1-4.	**Track class 1-4:** → A program of rail replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period.

	Track class 5-8: → To achieve SOGR and maintain operational performance, rail will be replaced every 45 years on all tangent running rail in track class 5-8. → To achieve SOGR and maintain operational performance, rail will be replaced every 40 years on all curved running rail in track class 5-8. **Obsolete Sections:** → All 119lb., 152lb. and 155lb. rail sections will be replaced at the earliest opportunity – as these sections are no longer manufactured. **Cascading:** → With the arrival of the new rail delivery train, a program of cascading rail from high track classes to low classes/yards/sidings will be developed.	**Track class 5-8:** → A program of rail replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 5-year period. → For efficient use of track access, replacement of rail will coincide with tie renewal if ties are life expired within 10 years of planned work or if they are wood.
Turnouts	**Track class 1-4:** → To achieve SOGR and maintain operational performance, replace turnouts every 35 years, depending on usage. **Track class 5-8:** → To achieve SOGR and maintain operational performance, replace turnouts every 35 years, depending on usage. → To maintain operational performance, wood tie turnouts will only be replaced with concrete turnouts when the surrounding wood tie tracks are replaced with concrete.	**Track class 1-4:** → A program of turnout replacement is introduced through this plan period. Proposals for new interlockings and configurations are under a heightened level of scrutiny by the Track Department to ensure zero net gain in turnouts and redundant or obsolete assets are removed as part of the proposals. **Track class 5-8:** → A program of turnout replacement is introduced through this plan period. Proposals for new interlockings and configurations are under a heightened level of scrutiny by the Track Department to ensure zero net gain in turnouts and redundant or obsolete assets are removed as part of the proposals.
Fence	To maintain SOGR, replace fences every 50 years.	A program of fence replacement will be developed through this plan period.

Capital Improvement		
Veltri Interlocking Improvement	→ To improve network performance and enable more maintenance opportunity in the future a new interlocking constructed east of Mystic.	→ Within current capital plan.
Bridge Approach Transitions	→ To improve ride quality and create conditions satisfactory for increasing class of track to increase operating speed, install treatments at approaches to open-deck bridges including concrete ties with under tie pads and cellular confinement systems in sub-ballast. First locations are in Chester Pennsylvania.	→ Within current capital plan.
Turnout Geometry Improvements	→ To install turnouts with better geometry on divergent side to improve ride quality, and after testing is complete, increase operating speed on divergent moves.	→ Within current capital plan.
National Network Improvements	→ Current renewal programs are focused on rail only. To enable future service improvements, a program of tie replacement (upgrading to concrete) and track layout improvements – including adding sidings as needed – should be delivered before new services are added.	→ Through this plan period, the asset management plan will be further developed for national network assets to ensure the infrastructure is in place prior to any planned service improvements.

Bridges and Buildings Lifecycle Management Strategy

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To prevent insidious decline of B&B assets, continue to perform inspection & monitoring activities based on Amtrak standards.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform preventive maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Corrective Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform corrective maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Capital Maintenance		
General	→ To prevent insidious decline of B&B assets, continue to perform capital maintenance activities based on Amtrak standards.	→ No significant change to current practice.
Capital Replacement		
Movable bridges	→ To return movable bridges to a SOGR and improve network performance, a separate strategy has been developed for each bridge. For long-range planning purposes the expected design life of movable bridges is 150 years.	
Signal bridges	→ To return signal bridges to a SOGR, a separate strategy is being developed for each asset. For long-range planning purposes the expected design life of signal bridges is 80 years.	
Bridge ties	→ To maintain SOGR, replace bridge ties every 25 years.	→ The bridge tie replacement program plans to replace 2,000 ties per year. The program for this plan period will far exceed that production rate.
Undergrade bridges	→ To return undergrade bridges to a SOGR and improve network performance, a separate strategy has been developed for each bridge. For long-range planning purposes the expected design life of undergrade bridges is 150 years.	
Culvert	→ To maintain SOGR, replace culverts every 80 years.	→ A program of culvert replacement will be developed through this plan period.
Tunnel renewal	→ To return tunnels to a SOGR and improve network performance, a separate strategy has been developed for each tunnel. For long-range planning purposes the expected design life of tunnels is 150 years.	
Retaining wall	→ To maintain SOGR, replace retaining walls every 150 years.	→ A program of retaining wall replacement will be developed through this plan period.

Capital Improvement	
The Northeast Corridor is one of the most complex and heavily used railroads in the world. Much of the corridor is not only in need of urgent rehabilitation but is also approaching the limits of its capacity. Addressing the SOGR backlog therefore provides an opportunity to address these network performance needs and ensure that the NEC corridor can continue to provide safe, reliable, and convenient high-speed rail service into the next century and beyond. A series of network performance improvement projects have been identified which could be advanced within the next five years should funding become available. These projects represent an opportunity to improve network performance while addressing needed SOGR backlog. The costs should therefore be considered in addition to the SOGR backlog identified previously.	
Baltimore and Potomac Tunnel Replacement	→ Replacement of B&P tunnel with a new tunnel and an improved alignment would both improve reliability and accommodate demand for future train service.
Susquehanna River Bridge Replacement	→ Replacement of Susquehanna River Bridge with new two-track fixed bridge high enough to allow boats to pass without opening.
East River Tunnel Rehabilitation	→ Rehabilitation of all four tunnels.
Pelham Bay Bridge Replacement	→ Replacement with a new higher-level fixed bridge with improved clearance for marine traffic.
Connecticut River Bridge Replacement	→ Replacement with a new movable bridge on an improved alignment.
Sawtooth Bridge	→ Replacement of Sawtooth Bridge a four-track structure, increasing efficiency and network operations.
Portal North Bridge	→ Replacement of Portal Bridge with a new high-level, fixed span bridge that would eliminate future malfunctions and improve reliability after malfunction.
Hudson Tunnel Project	→ Construction of a new two track tunnel (Hudson Tunnel), to allow for the existing North River Tunnel to be closed for reconstruction.

Electric Traction Lifecycle Management Strategy

Activity	Lifecycle strategy / benefit	Implementation strategy
Inspection/ Monitoring		
General	→ To ensure safe ET operations and prevent insidious decline, introduction of a general condition assessment of all ET infrastructure assets to support predictive analysis and investment planning/ prioritization.	→ Condition assessment framework rolled-out through plan period. → Aerial assessment of catenary structures.
Preventive Maintenance		
	→ To prevent insidious decline, a mid-life rehab program is needed in NED → To prevent failures, identify defects through various inspections and prioritize their correction	→ A program of Substation and Catenary rehabilitation rolled out through plan period. → A comprehensive program of varying inspections was developed and introduced in 2020.
Corrective Maintenance		
General	→ To ensure safe ET operations and prevent insidious decline, continue to perform corrective maintenance activities on ET assets as required.	→ No significant change to current practice.
Capital Replacement		
Catenary Structure	→ To maintain reliability and prevent insidious decline, perform a mid-life rehabilitation of the catenary structure every 38 years (estimated to cost 20% of capital replacement cost). → To achieve SOGR, replace catenary structure every 75 years.	→ A program of catenary structure rehabilitation will be developed and introduced through this planning period on a whole life cost justification basis. The program will be informed by the condition assessment being rolled-out through the planning period. → A program of catenary structure replacement is being introduced through this planning period. To manage the backlog of renewals, and provide a levelled work program, delivery of the work bank is spread over a 15-year period. This is to allow a production workforce to be established and continually utilized.
Catenary Hardware	→ To achieve SOGR, replace catenary hardware every 30 years.	→ A program of catenary hardware replacement is being introduced through this planning period. The program will be scheduled to align with the mid-life rehabilitation of the structure.

Catenary Wire	→ To achieve SOGR and maintain reliability, replace the catenary wire when the wire reaches 25% of the installed cross section (estimated to cost 30% of initial capital cost). For planning, wire is estimated to last 50 years.	→ A program of catenary wire replacement is being introduced through this planning period. The program will be scheduled to align with the catenary structure/ hardware replacement.
Third Rail	→ To achieve SOGR and maintain reliability, replace third rail every 40 years.	→ A program of third rail replacement is being introduced through this planning period. To manage the backlog of renewals, and provide a levelled work program, delivery of the work bank is spread over a 5-year period. This is to allow a production workforce to be established and continually utilized. The replacement of third rail will coincide with the replacement of running rail or ties if either of these expire within six years of the third rail.
Transmission Lines	→ To achieve SOGR and maintain reliability, replace transmission lines every 50 years.	→ The program, introduced in 2020, focuses on off-corridor transmission lines which present a high risk. → Replacement of on-corridor lines will coincide with catenary structure replacement.
Underground Cable	→ N/A	→ All transmission underground cable is currently in SOGR
Transformers/ Insulators	→ To achieve SOGR and maintain reliability, replace transformers/insulators every 40 years.	→ Transformers have been systematically replaced over the last 20 years.
Capital Improvement		
Off-Corridor Transmission Line Replacement	→ To maintain reliability and support network capability improvement, replace the off-property transmission lines.	→ Program developed during the planning period.
Ham to Clark Catenary Upgrades	→ To maintain reliability and support network capability improvement, upgrade the catenary and power systems on the NEC as well as allow the Acela 21 to achieve and maintain 160 mph MAS south of New York.	→ Program underway and continuing during the planning period.

Signals Lifecycle Management Strategy

Activity	Lifecycle Strategy / Benefit	Implementation Strategy
Inspection/ Monitoring		
General	→ To ensure safe Signals operations and prevent insidious decline, continue to perform inspection and monitoring activities on signals assets based on AMT-27 standard.	→ No significant change to current practice.
Preventive Maintenance		
General	→ To ensure safe Signals operation and prevent insidious decline, continue to perform preventive maintenance activities on signals assets based on AMT-27 standard. → To provide a more reliable Signals asset, introduce additional preventive maintenance to ensure signals assets remain in the required standard established in AMT-23.	→ No significant change to current practice. → Further preventive maintenance activities introduced to remove common causes of asset failures.
Corrective Maintenance		
General	→ To ensure safe Signals operation and prevent insidious decline, continue to perform corrective-maintenance activities on signals assets based on AMT-27 and AMT-23 standards.	→ No significant change to current practice.
Capital Maintenance		
Switch Heaters	→ To maintain reliability and prevent insidious decline, refurbish switch machines by replacing heating element and other components every 10 years.	→ Consistent with current practices. A program of switch heater replacement will reduce whole-life costs.
ABS	→ To maintain reliability and prevent insidious decline, selectively refurbish ABS components every 20 years – including replacing microprocessors and batteries.	→ A program of ABS-section rehabilitation is introduced through this plan period based on whole-life-cost justification.

ACSES (i.e., PTC)	→ To maintain reliability and prevent insidious decline, refurbish PTC system, including replacing in-ground components every 10 years and back-office servers every 7 years.	→ A program of PTC-system rehabilitation is introduced through this plan period based on whole-life-cost justification.
Central Instrument House	→ To maintain reliability and prevent insidious decline, selectively refurbish instrument housing components every 20 years – including micro-processors and equipment with reduced reliability or obsolescence issues.	→ A program of central-instrument-house rehabilitation is introduced through this plan period based on whole-life-cost justification.
Capital Replacement		
Switch Machines	**Track Class 1-4:** → To achieve SOGR, replace switch machines operating on class 1-4 tracks every 50 years. **Track Class 5-8:** → To achieve SOGR, replace switch machines operating on class 5-8 tracks every 35 years.	→ A program of switch-machine replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10-year period. This allows establishment and continual use of a production workforce. → A program of switch-machine replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 5-year period. For efficient use of track access, replacement of the switch machine will coincide with other interlocking hardware.
Switch Heaters	→ To achieve SOGR, replace the full switch heater cabinet and other components every 40 years.	→ Replacement will be conducted based on whole-life-cost justification and will coincide with Interlocking maintenance/replacement.
ABS	**Track Class 1-4:** → To achieve SOGR, replace trackside equipment, such as impedance bonds, on class 1-4 tracks every 50 years. This is typically consistent with the track renewal program. → To maintain performance, replace signals cable as required. **Track Class 5-8:** → To achieve SOGR, replace trackside equipment, such as impedance bonds, on class 5-8 tracks every 40 years. This is typically consistent with the track renewal program.	→ A program of ABS replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work bank is spread over a 10- year period. This is to allow a *production workforce* to be established and continually utilized. → Signals cable will be replaced—as required—based on whole-life-cost justification. → A program of ABS replacement is introduced through this plan period. To manage the backlog of renewals and provide a levelled work program, delivery of the work-bank is spread over a 5-year period. For efficient use of track access, replacement will include all cables and other 'system hardware'.

ACSES (Positive Train Control)	→ To maintain SOGR or support network capability improvement, replace system-wide PTC assets every 10 years or based on whole-life-cost justification of new technology.	→ System replacement will be based on whole-life-cost justification of replacement or introduction of new technology to support network capability improvements.
Central Instrument House	→ To achieve SOGR, replace central instrument housing assets every 40 years.	→ A program of central-instrument-house replacement is introduced through this plan period.
Grade Crossing	→ To achieve SOGR, wayside assets including gate mechanisms, flashes and instrument houses should be replaced every 25 years. Micro-processor-based components should be replaced every 20 years. Other components as required.	→ A program of grade crossing replacement is introduced through this plan period.
Movable Bridge	→ To achieve SOGR, replace movable bridge detection systems every 5 years.	→ Detection system replacement will coincide with other movable components.
Capital Improvement		
General	→ To improve network performance, establish a program to replace one interlocking and one ABS section per Division per year. The introduction of new technologies will be considered based on whole-life-cost justification.	→ A program of complete signal system upgrades has been introduced. This includes Q Tower, Oak to Bush and Thorn to Glenn.
PTC	→ To maintain network performance.	→ Included in the FY2018 and onwards capital program.
Wayside Signals Modernization	→ To improve network performance, program replacement of the wayside signals between interlockings with modern cab-based systems.	→ A program of wayside signals replacement is to be designed. This is to address reliability issues and remove old, obsolete technology as well as improve the capacity, OTP, and MAS of the NEC.
Air Switch Machines Modernization	→ To improve network performance, establish a program to replace older air switch machines with more modern electric switch machines (with the exception of Penn Station due to operational reasons).	→ A program of air-switch-machine replacement is introduced through this plan period, with the majority of air switches replaced over the next 5-year period. For efficient use of track access, replacement will coincide with the track renewal program.

Activity	Lifecycle Strategy/Benefit	Implementation Strategy
Inspection/Monitoring		
General	→ To ensure safe Communications operations and prevent insidious decline, continue to perform inspection activities on communications assets based on Amtrak standard.	→ No significant change to current practice.
Preventive Maintenance		
	→ N/A	
Corrective Maintenance		
General	→ To ensure safe Communications operations and prevent insidious decline, continue to perform corrective maintenance activities on communications assets based on Amtrak standard.	→ No significant change to current practice.
Capital Maintenance		
Shelters, Cabinets, Towers, Duct banks etc.	→ To maintain reliability and prevent insidious decline, rehabilitate all communication facilities—shelters, cabinets, towers, and ducts—every 15 years.	
Radio Systems	→ To maintain reliability and prevent insidious decline, rehabilitate the radio systems every 7 years (batteries etc.).	→ Delivery of radio system rehabilitation is spread over a 2-year period to level the work bank.
Capital Replacement		
Shelters, Cabinets, Towers, Duct Banks etc.	→ To achieve SOGR, replace all communication structures—shelters, cabinets, towers, and ducts—every 30 years.	
Radio Systems	→ To achieve SOGR, replace complete radio system every 15 years.	→ Delivery of radio systems replacement is spread over a 5-year period to level the work bank.

WAN/ Other Network Devices	→ To maintain SOGR, replace WAN and other network devices every 10 years.	→ Network devices are estimated to be over 20 years old. There is an urgent need to address the backlog over the next 10 years and replace all wayside equipment with fiber.
Application Systems (CCTV, PAS, Intrusion Detection, Access etc.).	→ To maintain SOGR, replace access control devices every 15 years. → To maintain SOGR, replace CCTV every 10 years. → To maintain SOGR, replace Public Announcement System (PAS) every 15 years.	→ Delivery of access control replacement is spread over a 5-year period to level the work bank. → CCTV replacements are typically driven by changes to technology and often funded by grants. Replacement decisions are based on whole-life-cost justification. → Delivery of PAS replacement is spread over a 5-year period to level the work bank.
C-Tec servers (4 of), and CNOC servers (1 of)	→ To maintain SOGR, replace C-TEC and CNOC servers every 5 years.	→ Delivery of server replacement is spread over a 2-year period to level the work bank.
Capital Improvement		
General	No communication system upgrades are planned within this plan period. The introduction of new technologies will be considered based on whole-life- cost justification.	

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