Federal Railroad Administration
Track Safety Standards
Compliance Manual

Chapter 3
Automated Track Inspection Program
(ATIP)
Geometry Car Operation

Office of Safety Assurance and Compliance
Track and Structures Division

July 22, 2008

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CHAPTER 3

Track Geometry Inspection Car Operation

Background

This chapter provides functional understanding of the Automated Track Inspection Program (ATIP) in terms of operation, policy, on-track safety requirements, geometry measurement technology, and national deployment of the Federal Railroad Administration (FRA) railbound inspection cars. Under the statutes mandated by Congress, ATIP cars conduct operational surveys of the United States rail transportation network for the singular safety function of determining railroad compliance with *Federal Track Safety Standards* (TSS). Since 1974, the operation of ATIP cars serves an important role in FRA's overall compliance programs. FRA's Office of Safety manages the program and logistic support is provided under a contract.

ATIP Track Geometry Inspection Car Operation

All FRA Inspectors assigned to ATIP cars are to ensure applicable compliance with railroad operating rules, special instructions, and specific FRA policy and procedures by everyone on board when ATIP geometry cars are operated.

The seven ATIP cars are identified by UMLER[1] (listed as private equipment) and publicly recognized with the DOTX prefix on the car body above the truck. They are officially DOTX series 216, 217, 218, 219, 220, 221, and 223. ATIP cars DOTX 217, 218, and 219 are self-propelled; DOTX 216, 220, 221, and 223 require towing by a locomotive, but all the cars may be operated in tow mode, if necessary.

FRA policy defines the self-propelled ATIP cars as specialized maintenance equipment (SME) and they may not reliably shunt track signal circuits. As a result, certain operating restrictions apply. By policy, ATIP cars are not considered locomotives[2] (even though they have cab controls and couplers). Operating as an SME relieves ATIP contractors from maintaining locomotive engineer certification and hours of service regulations and other requirements. As an SME, self-propelled ATIP cars are not subject to Title 49 Code of Federal Regulations (CFR) Part 229, but are amenable and will act in accordance with the safety appliance section and other pertinent sections of the regulations.

ATIP cars operate safely in accordance with all railroad operating rules. ATIP self-propelled geometry car movement has one rule exclusion; opposing and following absolute block protection must be maintained and supersedes railroad operating rules or equivalent protection given to a train[3] or on-track equipment.

ATIP cars offer advances such as crashworthiness protection, high-speed trucks, satellite communication, and asset management—including innovations in ride-quality accelerometer measurement and the differential global positioning system (GPS) for precise location of track exceptions. FRA has developed a secure Web site accessible at http://atip.fra.dot.gov to facilitate and improve communications. The site contains survey schedules and operational information.

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[1] UMLER is a registered rail equipment reference, e.g., DOTX 217 is the same as T17, etc.

[2] 49 CFR Part 229 Subpart A - General § 229.50 (k) Definitions

[3] 49 CFR Part 236 Subpart G - Definitions § 236.832 - Train

On-Track and Onboard Safety

ATIP cars are required to operate safely in accordance with railroad rules, Federal regulations, and FRA policy. Safe ATIP inspection surveys are the responsibility of everyone on board. Assigned FRA personnel are responsible for the authority, enforcement, and control of this policy. Report any unsafe situation to FRA regional or Headquarters (HQ) managers.

ATIP contractor employees must conduct activities in accordance with the specific instructions conveyed in the *Safety Manual for FRA Survey Cars.* The Federal Track and Operating Practices (OP) Inspectors, in coordination with the Survey Director, will provide a job briefing on general geometry car safety, apparatus, and on-track protective procedures whenever anyone comes on board or leaves the ATIP car and fouls a track. The on-track safety job briefing will discuss at a minimum the following:

1. General communication methods and procedures during emergencies,
2. Location of geometry car safety apparatus (i.e., fire extinguishers, first aid kits, breathing apparatus, and identifying individuals on board who are trained in CPR),
3. Procedures for egress through specific doorways and windows, and
4. Applicable physical and operating hazards and procedures when fouling the track.

The FRA Track and OP Inspectors are responsible for ensuring that everyone on board the ATIP car is briefed and updated, as safety conditions or events change throughout the day. Before exiting the car and fouling the track occupied by the survey car, on-track safety is established by utilizing the ATIP car's exclusive authority to move on controlled track (train coordination). All train movements are coordinated with the Survey Director.

Whenever the ATIP car stops to evaluate a track condition, conduct instrumentation checks, or carry out repairs, FRA Track Inspectors will ensure the following:

1. A railroad employee in charge ensures appropriate on-track safety requirements and a job briefing before fouling the track.
2. FRA Track Inspectors, the railroad employee in charge, and ATIP car personnel are reminded that train coordination, as previously discussed, in coordination with the Survey Director, may afford on-track protection. Before fouling any other track protection such as train approach a warning must be used.

If a railroad employee is unavailable to assume the in-charge role, the FRA Track Inspector may afford on-track safety in accordance with FRA policy as follows:

1. Two FRA or State Inspectors may work together and use train coordination as protection on the track occupied by the survey car and on non-controlled track with one acting as a watchman/lookout for the other, if they know the operating characteristics of the railroad at that inspection point, including train speeds.
2. An FRA or State Inspector working alone is authorized to use train coordination on the track occupied by the survey car or individual train detection on non-controlled track. The individual Inspector's responsibility is to obtain the information necessary to provide proper on-track safety.

FRA or the railroad may invite guests on an ATIP car. However, guests are not authorized to occupy the track without the permission and protection afforded by either FRA or the railroad.

The term "guests" does not include ATIP contractor personnel who are agents of the Government.

Operations

ATIP crewmembers usually consist of a Survey Director and three others whose responsibilities include safe operation of the car, calibration and maintenance of the instrumentation, and collection of survey data. ATIP car survey operations generate a track geometry inspection report (TGIR) and include video charts and imagery in both hard copy and electronic format.

A survey schedule is distributed regionally. FRA Track and OP Specialists review the schedule outline and provide route feedback 4 months prior to an ATIP survey date. Upon regional acceptance, the schedule routes are applied to a monthly calendar format and accessible on the ATIP Web site at http://atip.fra.dot.gov.

As a contract requirement, an Office of Safety official notification letter and an operations plan are distributed to the respective railroads and applicable regions at least 3 months in advance of the survey. The content of the letter details FRA's authority, operations geography, contact personnel, and other pertinent information. A daily ATIP schedule identifies normal railroad crew change points that estimate travel time that the ATIP car should achieve in a 12-hour day.

Daily Deployment

An active survey contract workday averages 13 hours per day with 1½ hours consisting of pre- and post-survey work. Survey on-duty time should not extend beyond 12 hours. However, it is understood that certain justifiable operating delays might occur from a variety of causes; unforeseen railroad operation, ATIP car equipment failure, or an emergency occurrence. Conditions that explain the reason for excessive delays beyond 12 hours require documentation by the contractor, concurrence by the Track Inspector, and preapproval by the regional and HQ managers, as necessary. Provable operational delays, which result in going beyond the hours of service because of subjective decisions to reroute and give priority to other traffic, must be well documented. If unreasonable delays occur due to differential priority treatment, the railroad may be subject to forfeiture of reimbursable costs and fined under the law or regulations.

Occasionally, the ATIP schedule may be altered to correspond with minor changes effecting daily start and stop times or locations. The distribution and coordination of necessary schedule modifications to the respective railroads and FRA regions, by way of earliest means, is essential. There should be no substantive changes to the final schedule 2 weeks prior to the survey, unless an unforeseen circumstance occurs. Last minute changes have an undesirable effect and are difficult to make and affect the overall schedule in other regions and railroads.

ATIP priorities and risk-based route scheduling preference involve primarily:

1. Inspector observations, regarding deteriorating or noncomplying track geometry, associated with structural conditions, e.g., crossties, ballast, etc.;
2. A railroads compliance history, exception repeatability, degradation rate, and track quality;
3. Duration between last inspections (i.e., between 2- and 4-year cycles where tonnage is more or less than 50 million gross tons, respectively);
4. Passenger operation (i.e., Amtrak and applicable commuter/freight territories, such as Southeastern Pennsylvania Transportation Authority (SEPTA), Metropolitan Rail

Corporation (METRA), Long Island Railroad (LIRR), Northeastern Illinois Regional Commuter Rail (NIRC), etc.);

5. Designated hazardous material and strategic rail corridor network (STRACNET) routes;
6. Railroad operating speeds greater than 20 mph, and
7. Other special regional needs or activities (e.g., the 2002 Winter Olympics in Utah).

Generally, DOTX 217 is assigned to regions west of the Mississippi River and DOTX 219 assigned to regions east of the river. DOTX 220 is primarily designated to survey passenger routes nationwide.

Regions located in the northern latitude are normally scheduled in late spring through early fall and those in the southern latitudes can expect the ATIP car through the winter months. ATIP's goal is to survey 100,000 miles of track per year and provide reliable track data.

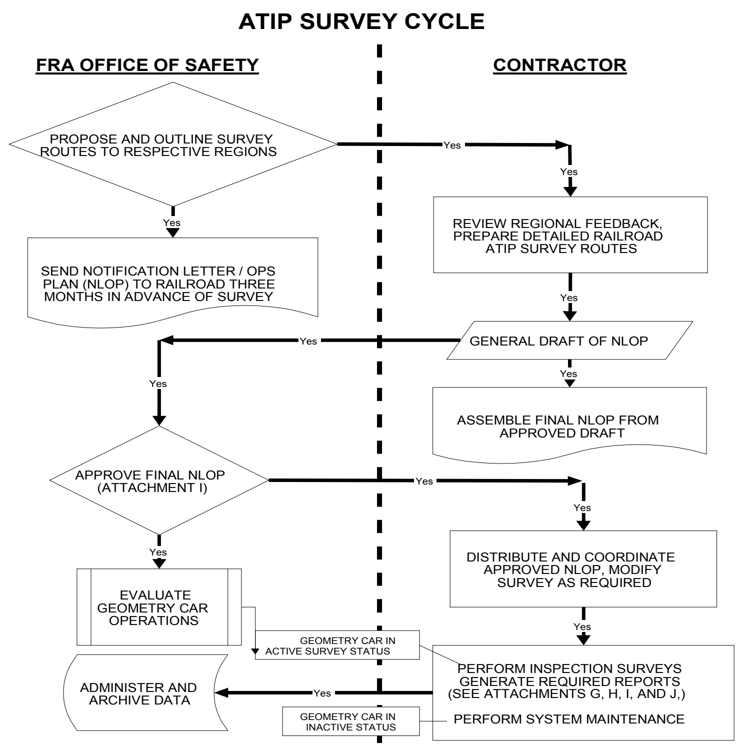

Figure 1

Track Geometry Measurement System (TGMS)

Onboard ATIP cars, TGMS instrumentation generates automated signals processed online by a computer, which produces a graphical record of detailed track geometry measurements. The measurements recorded are gage, left/right rail alignment and profile, crosslevel, Superelevation, warp, harmonic rock, run-off, and limiting speeds. ATIP cars measure and record existing track geometry conditions and compare those measurements to ensure compliance with TSS 49 CFR Part 213, Subpart C for the lower speeds (Class 1–5), as well as the Subpart G (Class 6–8) high speed to determine compliance with:

1. Run-Off in 31 feet;
2. Track gage in inches, measured ⅝ inch below top of rail[4];
3. Curvature;
4. Length of spiral portion of curved track and rate of elevation run-off or run-on;
5. Crosslevel on tangent track in inches;
6. Crosslevel deviation from uniformity on spirals and curved track in inches;
7. Warp using a variable base length up to 62 feet on tangent, spiral, and curved track, in inches, and a 31-foot section on spiral track;
8. Limiting speed (mph) in curves (based on amount of Superelevation and degree of curvature);
9. Left and right rail profile (humps and dips) deviation from uniformity of a 31-, 62-, and 124-foot midchord offset (Class 6 and above) in inches;
10. Harmonic rock, as created by six pairs of low joints, each pair exceeds 1¼ inch;
11. Left and right rail alignment deviation from uniformity of a 31-, 62-, and 124-foot midchord offset (Class 6 and above) in inches; and
12. Calculated unbalanced amount in inches.

TGMS Definitions

Crosslevel: Difference in height between opposing rails.

Gage: This is defined as the distance between the rails, measured at a right angle to the rails, in a plane ⅝ inch (1.59 cm) below the top of the rail.

Superelevation: A constant elevation of the outside rail over the inner rail maintained on curves, as well as a uniform rate of change on spirals, and measured in the same manner as crosslevel.

Warp: This is the rate of change in crosslevel along the track and is the difference in crosslevel between any two points (tangent, spiral, or curve) 62 feet (18.90 m) apart or less.

Twist: The difference in crosslevel between the fixed lengths of 11, 22 and 31 feet (3.35, 6.71, and 9.45 m). TGMS is capable of determining a value for twist at the same rate that crosslevel and Superelevation is determined.

Profile: (Vertical surface) as crosslevel relates to transverse plane in track elevation, profile relates to elevation along the longitudinal axis, which is an adherence to an established grade and the incidence of dips and humps.

Alignment: Alignment is the projection of the track geometry of each rail or the track center line onto the horizontal plane.

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[4] Excessive vertical and horizontal rail headwear loss or rail section design may produce errors, unless properly adjusted.

Curvature: Both tangent and curve track alignment are defined as the deviation of the mid-offset from a 62-foot chord

Run-Off: Elevation (ramp) difference of a line along the top of the rail is used for the projection.

Exception Detection

The exception detection process compares the geometry data to the exception thresholds. When an exception is detected, the exception detection process provides the type of exception, the location (start of exception, end of exception, and peak location), and the value of the exception.

Stripchart (Oscillograph)

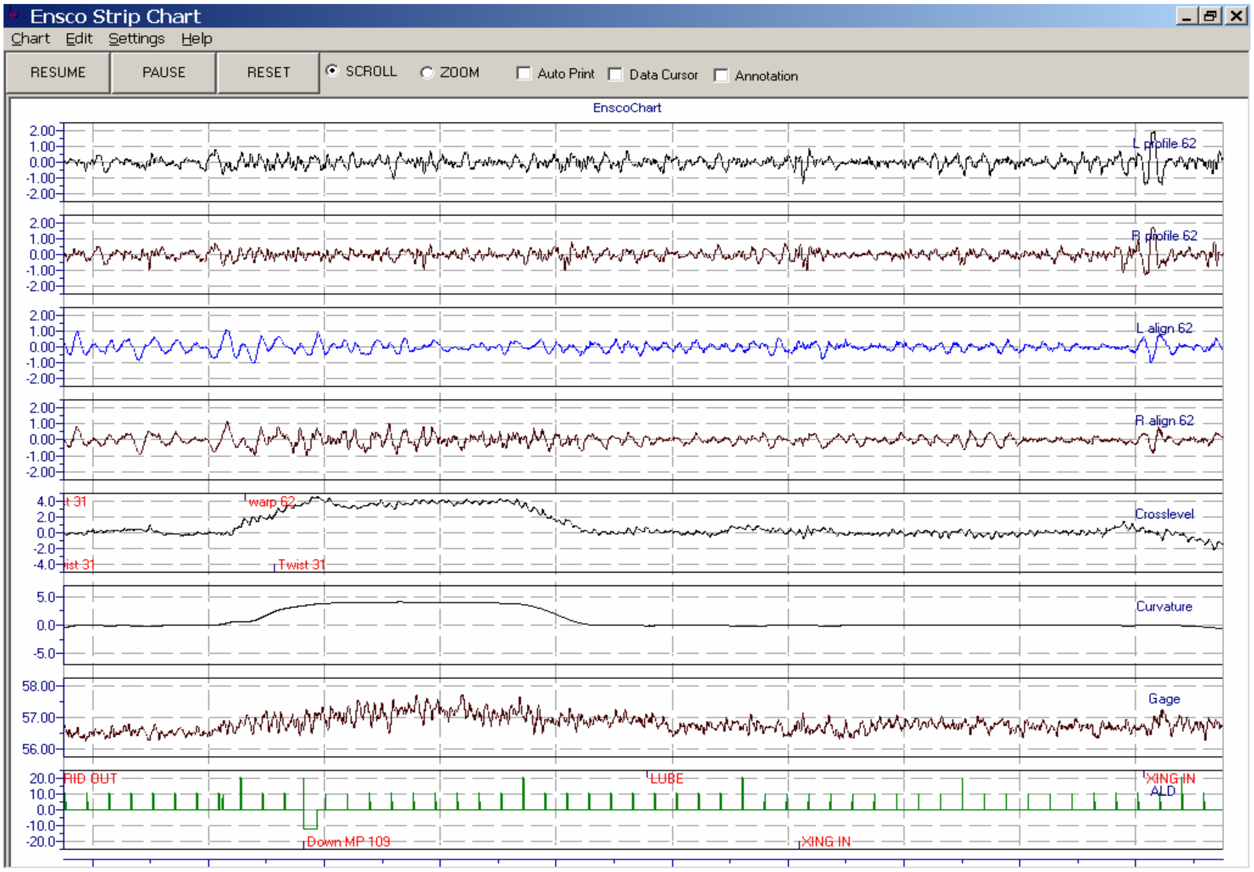

Figure 3

The multichannel video stripchart (illustrated in Figure 3 top to bottom) continuously displays geometry values, i.e., left and right rail profile or run-off, left and right rail alignment, crosslevel or curve Superelevation, degree of curvature, gage, and automated track event location detection (ALD) references.

When viewing the stripchart, the ATIP car direction is always from the left-hand margin toward the right-hand margin. Representative lines, drawn on the stripchart, infer statements of track quality. The dash lines represent the upper and lower class limits. The exception trace lines differentiating noncomplying conditions may indicate operational and/or maintenance remedial action is necessary. Electronic and paper copies of the stripchart defects are provided on demand so that noncompliance with Federal regulations receives immediate attention. In an effort to reduce paper consumption, Inspectors can view ATIP geometry information electronically on GeoEdit software via CD-ROM or it is viewable on the Track Data Management System ATIP Web site. The eight channels are selectable in any order on GeoEdit. Exception limits are shown in the left-hand margin. The video stripchart no longer needs a scale to measure analog readings because listed exceptions are displayed on the video stripchart.

The profile channel combines left and right profiles and shows run-off. Exception limits are shown in the left-hand margin. The centerline is equal to zero, profile measurements above the centerline indicate a dip, and profile measurements below the centerline indicate a hump.

The alignment channel displays left and right rail alignment. Exception limits are shown in the left-hand margin. On tangent track, the centerline is equal to zero; alignment exceptions above the centerline are considered outward from the track center, and measurements below the centerline are considered inward to the track center.

The crosslevel channel combines to illustrate crosslevel deviation, warp, rockoff hazard, and Superelevation. Exception limits are shown in the left-hand margin. A line plotting to the top of the centerline indicates the left rail is the high rail, and plotting to the bottom of the centerline indicates the right rail is the high rail.

The curvature channel displays three scales, which are 5, 10, and 20 degrees of curvature. Exception limits are shown in the left-hand margin. Correct selection of curvature (5, 10, or 20 degrees) is dependent upon the physical layout of the track. Exception trace lines plotting to the bottom of the centerline are left-hand curves and plotting to the top of the centerline are right-hand curves, as viewed in the direction of travel (such as left to right).

The gage channel displays wide and narrow gage. Exception limits are shown in the left-hand margin. Nominal gage is 56½ inches. The centerline is equal to 57 inches, measurements above and below the centerline is read directly as either wide or narrow gage, respectively.

The ALD channel is usually illustrated on the very bottom. Each milepost marking, track number, and current class of track tested is reported and assists in locating track exception. The curvature scaling with the file number (in the year, month, day, and file number format [yymmddxx]) is posted on the right border. Location references consist of event message numbers that clearly indicate mileposts and other wayside features such as road crossings, bridges, and trackside detection devices (e.g., hot boxes and clearance devices) are detected and manually entered in the data stream by the contractor. Small and larger vertical lines indicate 100- and 1,000-foot track segment division, respectively.

Other features may be marked automatically on the chart when ALD equipment senses their presence magnetically (i.e., turnouts and wayside detection devices). This allows Inspectors and host railroad representatives to easily locate exceptions from either the analog or video chart references at the time of occurrence.

Video Stripchart

A video stripchart outline begins with a header that contains the following information:

- Date,
- Railroad name, division, subdivision, and line code segment,

- Geometry car (i.e., DOTX 219),
- Survey number,
- Movement authority,
- Track class,
- Location from,
- Location to,
- Posted speed,
- Milepost start/end,
- Track,
- Type (single, multiple, double main, etc.),
- Track direction (north, south, east, or west),
- Scan rate, and
- Video number.

The stripchart is a continuous printed output of the following information:

- Wayside features (bridges, turnouts, etc.),
- Left profile,
- Right profile,
- Left alignment,
- Right alignment,
- Crosslevel/Superelevation,
- Gage,
- Warp, and
- Speed.

The information is arranged as a plot where each of the measurements, with the exception of the wayside features data, forms a continuous line moving to the left or right as the measurement changes.

Track Geometry Inspection Report (TGIR)

The TGIR contains a list of all exceptions identified during a survey. The report header includes:

- Location and name of events, including speed and class of track changes,
- Header information,
- Exception,
- Start location and footage,
- End location and footage,

- Length of exception,
- Differential GPS locations,
- Maximum value,
- Maximum value location,
- Exception limit,
- Track,
- Maximum train speed,
- Posted class (timetable),
- Complying track class (differentiating one class or more than one class drop),
- Space for date corrected, and
- All other outputs from additional measuring devices (rail profile and corrugation).

Manual or automatic entry supplemental information is required to properly evaluate and locate track geometry exceptions. Therefore, provisions are incorporated to permit the Data Specialist to enter other exceptions, such as:

- Milepost number,
- Track class (FRA TSS 1 through 8),
- Track type (passenger, freight, or both),
- Track number, and
- Track or wayside features.

Number of Channels

At least eight channels can be displayed that may be selected from all stored data from the TGMS or the Ride Quality Measurement System (known as RQMS). All appropriate scales for each channel are marked on each chart. At a minimum, the following channels are displayed:

- Left profile,
- Left alignment,
- Right profile,
- Right alignment,
- Superelevation,
- Curvature,
- Gage,
- Location,
- Car body lateral acceleration,
- Car body vertical acceleration,
- Truck frame lateral acceleration, and

- Truck frame vertical acceleration.

Standard Operating Procedures (SOP)

Test Speed Classification

ATIP cars always comply with the operational speed requirements, but FRA policy does not necessarily recognize all "slow orders" in terms of track classification. Railroads place general order (GO), or track bulletins (TB), for a variety of justifiable reasons, i.e., operational, structural, and geometry, which are substituted for the maximum authorized train speed. Railroads also may elect to reduce train speed to expedite train and ATIP car movement in advance of ATIP surveys by placing a temporary or provisional slow order (TSO), so-called "blanket slow orders," over long segments of track. Geometry data may be reprocessed to the maximum authorized train speed. An FRA Track Inspector has discretion and the final authority to accept a TSO, but not a valid and verifiable GO or TB.

For example, a timetable authorizes freight trains to operate at 40 mph, or Class 3 classification. However, a valid and verifiable TB reduces freight speed to 25 mph, a Class 2 classification, because of a crosstie condition. As a result, Inspectors will allow ATIP cars to inspect and record noncompliance to the Class 2 safety limits. In another example, on the day of the survey a railroad issues a slow order reducing train speed from 70 mph (Class 5) to 60 mph (Class 4) for operational reasons, such as anticipating multiple slow orders. This lowered speed will be less disruptive to the dispatcher and actually increase cooperation with ATIP car movement. Inspectors will accept the lower classification operating speed but will allow the ATIP car to inspect to the posted higher classification in accordance with the timetable speeds.

Any ATIP exception location and value discovered may only be edited by the Inspector (through the Survey Director) from the TGIR because of precision, accuracy, repeatability, and reproducibility (PARR) uncertainty. However, track exceptions are only deleted from the TGIR and not exclusively removed from TGMS storage. Thus, exceptions are always available for subsequent review, analysis, and reprocessing.

FRA Inspectors are not permitted to allow ATIP track inspection testing at a higher class of track than the maximum authorized or posted operating speed contained in a current timetable without HQ approval. If a railroad requires this type of track quality analysis, a request should be forwarded and, as resources are available, the request will be processed and forwarded to the railroad.

Clearance Restrictions

Prior to the survey, FRA Inspectors will coordinate with the Survey Director regarding current track number(s), current authorized operating train speeds, and track charts (curvature) input information for the survey. For TGMS to correctly plot the degree of curvature on video or stripchart, FRA Inspectors will advise the Survey Director in advance on where curvature varies or differs from those established on a track chart in groups of 5, 10, or 15 degrees.

ATIP geometry cars comply with Association of American Railroads interchange rules, however track curvature greater than 13 degrees presents certain clearance issues and may govern or restrict car operation when towed by a locomotive. Self-propelled cars or towed operation of cars on curves greater than 20 degrees is prohibited. Clearance diagrams and restrictions of all ATIP cars are provided on the ATIP Web site.

Use of Additional Locomotive(s)

Self-propelled ATIP geometry cars operate independently; however, they may need towing occasionally. FRA Inspectors (in agreement with the Survey Director) are authorized to request a tow locomotive and crew, if one or more of the following occur:

1. The propulsion system and/or the braking capabilities fail to operate properly or,
2. The railroad's operating rules require onboard automatic cab signal, automatic train stop, or automatic train control systems. Consequently, the ATIP geometry cars do not have these features and must be towed by a railroad-owned and -equipped locomotive, in accordance with railroad signal rules or the maximum authorized track speed, whichever is lower.

In all other cases, FRA HQ will authorize, and must be notified in advance, the lease of a locomotive(s), the use of essential railroad crewmembers, and the reimbursement of the cost service to the railroad.

Track Designation

For the purpose of ATIP surveys, the TGIR designates Tracks 1 through 4 as standard notations for double or multiple controlled track configuration, unless otherwise numbered by the railroad (alphanumeric [ABCD.1234] format). For example, a track may be designated as YL10.45. A single main track is designated as Track 5. A controlled siding is designated Track 6, and Track 7 notations represent all "other than main" noncontrolled tracks and includes excepted track.

Operational Delays/Surveys Beyond 12 Hours

FRA Inspectors are to report excessive delays greater than one-half hour and cumulative delays resulting in time exceeding the hours of service law. For example, hours of service time begins when the ATIP car conducts its brake test. Inspectors will ensure the Survey Director reports recurring or prolonged operational and repair delays, and determine the reason for the delays and/or operating constraints that are placed by the railroad (e.g., dispatching and crew delays or personnel hours of service restrictions). Inspectors are to notify regional and HQ managers if any unusual occurrence significantly affects ATIP daily schedules. The use of the onboard telephone(s) to communicate with railroad officials to expedite movement and advise regional and HQ managers is authorized.

Although normal survey hours are expected to be conducted during daylight, operations may require surveying before sunrise and after sundown. Inspectors should address any safety concerns in a safety briefing. Personnel on board ATIP cars must know their individual limit for physical fatigue beyond 12-hours of on-duty time. At any time an unsafe circumstance exists that does not conform to railroad or ATIP procedures and instructions, the situation will be immediately addressed, resolved, and reported to FRA regional or HQ managers.

Regardless of day or night, the TGMS will always record the track conditions and produce a TGIR, unless TGMS equipment malfunctions, as specified below.

Measurement Equipment Malfunction

In collaboration with the Survey Director, Inspectors will monitor the stripchart exceptions and verify that all channels are within scale and reading properly. Inspectors will convey this information to railroad maintenance-of-way representatives ensuring a complete understanding of the data presented. A single-point failure or combination that exhibits questionable value or information of any exception, is justification to stop the survey at that location until it is repaired. A survey will not continue until the conditions are resolved. If repairs cannot be made to the geometry measurement system, ATIP surveys are not to be continued. The track segment affected will be declared as an invalid survey. Track segments identified as invalid will be rescheduled for an ATIP inspection at a later date.

Certain conditions are known to produce small variations in measured track geometry during automated surveys. These differences affect geometry measurement and are mainly caused by:

1. TGMS calibration tolerance.
2. Transition in the applied track load between survey run dates caused by speed, acceleration, or weather conditions.
3. Difference of 1-foot data sample locations.
4. Changes in track position caused by:
   - prevailing rail traffic
   - rail temperature variations
   - physical conditions: rail and wheel
   - certain types of guardrails
   - flangeway obstructions.

Under the rail profile system, specific rail sections (headfree rail) and special track work may affect where the ⅝ point on the gage side of the rail is measured automatically. Extreme vertical headwear loss (greater than 40 percent) also presents problems associated with proper measurement. This rail condition may influence the accuracy of the TGMS and is identified on the TGIR. Under International Organization for Standards (ISO) certification, the conditions are minimized and controlled. Significant lengths of this type of rail condition may warrant an adjustment to the gage sensor by the Survey Director, but these adjustments must be authorized by FRA HQ. Where a significant amount of headwear loss is prevalent, FRA Inspectors are to advise and discuss the rail condition with the railroad. Headwear loss values can be viewed with the Rail Profile System and on GeoEdit.

Valid and Invalid Surveys

ATIP cars inspect and produce a TGIR of all applicable mainline tracks, controlled sidings, and ”other than main track” when scheduled, warranted, or the opportunity is practicable. For example, occupying a main track and directed to occupy a siding to meet another train would present an inspection opportunity on the siding track. Unplanned inspection of main or yard track, including “excepted track” designations is discretionary, however, care must be taken to prevent possible ATIP car damage from a variety of sources. Producing a TGIR is mandatory for a valid survey and will not be produced for invalid surveys or certain track segments thereof.

For ISO quality reasons, ATIP cars record geometry data when moving above a certain speed, except where conditions exist to cause damage or as designated by FRA HQ. Anywhere the ATIP car operates the TGMS instrumentation on board will record applicable track geometry measurements. An authorized or valid survey operation occurs on the condition that the following prerequisites are in place:

1. The railroad is officially notified by FRA in writing,
2. A qualified railroad locomotive engineer/pilot is on board (self-propelled or towed),
3. Both contractor crewmembers and FRA Inspectors are on board,
4. Authorized track speed is greater than 5 mph, and
5. TGMS is online, functional, and can produce a TGIR.

An unauthorized or invalid survey (segment thereof) operation is declared if the following circumstances occur:

1. TGMS failure resulting in instrument inaccuracy,
2. TGMS instrument impairment due to snow, vegetation, high ballast levels or excessive debris, mud, and grease/oil causal factors,
3. The geometry car is "deadheading" in a train, and TGMS is offline,
4. Performing PARR testing, undergoing scheduled or unscheduled maintenance.

Producing a TGIR is mandatory for all valid surveys. A TGIR will not be produced for invalid surveys. When valid TGIRs are produced they will be provided to the host railroad by the Inspector only. Those locations where certain track segments were deemed to be invalid, the Inspector will NOT provide geometry data to the host railroad.

Geometry Car Exception Levels

Discovered exceptions by ATIP cars are categorized into three noncompliance levels: first-level (class) noncompliance, second-level (serious) noncompliance*,* and third-level (unsafe) noncompliance. For example, a track that is tested at an operating speed of Class 4 but only complies with Class 3 is defined as a first-level noncompliant condition—a one-class drop. A track that is tested at an operating speed of Class 4 but only complies with Class 2 or less is defined as a second-level serious condition—a two-class drop or more.

Any track, regardless of classification, that does not comply with any safety standard (does not at least comply with Class 1 track) is defined as a third-level, unsafe condition. Without immediate and proper remedial action, an unsafe track condition, in all likelihood, will result in a derailment.

Exception Location

There are two basic methods of locating exceptions using the TGIR:

1. Download or enter GPS data (latitude and longitude) into a handheld GPS device such as a Digital Track Notebook (DTN). Follow GPS directions to the exception. GPS exception coordinates are listed in the TGIR, and
2. The geometry car exception paint marking system has been removed and no longer sprays paint on the crossties but Inspectors may use the Oscillograph (stripchart) and the TGIR to find the track number and footage beyond a milepost reference to locate exceptions. Use the stripchart information to also reference exceptions to other geographical features (turnouts, grade crossings, curves, etc.).

Sometimes detection problems are encountered for reasons such as erroneous manual entry from the ATIP car, missing mileposts, and "short" miles, which means a railroad may not measure exactly 5,280 feet in length. The rule is the exception distance is referenced in the direction of travel regardless of increasing or decreasing mileposts. The TGMS counts the number of feet from the last entered milepost. According to the TGIR, if the mileposts are increasing (e.g., 9, 10, 11, etc.), the footage from a milepost is added and directly read, i.e., an exception located at Milepost 10+1,584 feet would be interpreted as 1,584 feet from Milepost 10 (decimally Milepost 10.30) in the direction of travel.

If the mileposts are decreasing (e.g., 11, 10, 9, etc.), the footage on the report from a milepost is subtracted from the milepost. For example, an exception located at Milepost 10+1,320 feet (specifically between Milepost 10 and Milepost 9), would be interpreted as 1,320 feet from Milepost 10 or located at Milepost 9+3,960 feet (decimally Milepost 9.75) in the opposite direction of travel. An Appendix: Conversion Feet to Decimals of a Mile is available on board and at the end of this chapter to assist Inspectors. Dependent upon geometry car speed, a delay reaction time (translating to a distance of up to 400 feet) exists regarding exceptions.

Geometry exceptions, associated with a length (i.e., gage, warp, and harmonic rock), are measured from an exception reference point in the direction of travel. For example, a warp length of 56 feet is located at Milepost 9+3,960 feet, upon computer calculation, the other end to the warp is located at Milepost 9+3,904 feet (56 feet from the exception reference point, but in the opposite direction of travel). Use of the DTN or other GPS receiver accuracy is usually within 30 feet of the exception location “tagged” with the geometry car GPS coordinates.

Exception Verification

ATIP’s TGMS (instruments, algorithms, and SOPs) are certified by ISO 17025 standards and meets the quality procedures set by those standards for all ATIP cars. As part of ISO A2LA certifications, instrument verifications (IV) are made a minimum of three times per day and stripcharts are continuously monitored to ensure that TGMS is not out of allowable tolerances. Track gage conditions deemed as unsafe (in excess of 58½ inches) must be field verified. FRA Inspectors must stop the ATIP car when encountering an unsafe level condition and verify geometry car measurements. All other on-track verifications will be at the sole discretion of the Inspector. ATIP also conducts specialized random quality assurance field validations.

Railroads may question the accuracy of a reported exception. In those cases, the FRA Inspector may stop the car and substantiate the exception by conducting additional instrument verifications and/or direct track measurements, as long as the activity is supervised under proper on-track safety procedures. If track structure and operating circumstances warrant, Inspectors may assess and consider a violation citation, in accordance with Chapter 4.

ATIP satisfies 49 CFR § 213.13 requirements to measure track under load. ATIP cars normally apply a lateral and vertical dynamic load and correspondingly, TGMS calculates the geometry compliance. Speed and impact factors determine the level of rail movement under load. Measurement under load (dynamic) must always be considered—the only exceptions are narrow gage, and guard face and check gages. Car wheels forcing a narrow gage or guard check and face gage condition outward are not measurement-appropriate under load (49 CFR § 213.13).

It is important for the Inspector to verify (reinspect) geometry measurements following an ATIP survey (see Source Code J). Inspectors should be confident geometry measurements are correct and accurate, and they should be ready to disprove any contentions that the measurements aren’t accurate. Also keep in mind that static measurements will almost never exactly equal that of a dynamic (100-ton car) measurement.

Exception Remediation

Providing the ISO quality standards are met, Inspectors will recognize exceptions discovered by ATIP cars as abiding to FRA's constructive knowledge standard in accordance with 49 CFR § 213.5 responsibility and FRA policy. It is the railroad's responsibility to decide the remedial action when notice is given (ATIP survey), stating that their track does not comply with the safety standard requirements. Proper exception remedial action must be taken at the time of discovery by railroad representatives. Inspectors may not impose remedial action en route, except when stopping and verifying validity or in response to railroad remedial action. Inspectors may also consider citing violations when conducting an on-the-ground reinspection of an unsafe track condition (see Source Code J).
After an ATIP survey, reinspections determine if appropriate remedial actions have been taken and are at the sole discretion of the Inspector. Proper source codes for this are located in this section under "Reports." Prior knowledge is met when the railroad is given a TGIR and enforcement action should be considered when remedial action has not been taken.

Reverse Movement

To accomplish on-the-ground track exception verifications or for other purposes, ATIP car movement in the reverse direction will be conducted in accordance with railroad operating rules. Pilots will position themselves to oversee the reverse movement and communicate with the car operator in accordance with railroad operating rules. Only DOTX 217 and 218 have dual controls at each end. Reverse movements are limited by:

1. Operations through an interlocking,
2. Operations over multiple highway-rail grade crossings, or
3. Operations of a significant distance (usually 2 miles or more).

Speed Limitation on Curves

The V_{max} formula considers the average variable of actual elevation and curvature, and the amount of unbalanced elevation or cant deficiency in determining the maximum curving speed allowed. Curving forces become more critical if variations in track, equipment characteristics, or improper train handling conditions have not been abated. FRA Inspectors are to determine compliance with the track surface standard in 49 CFR § 213.63 or the alignment standard in 49 CFR § 213.55, which in some cases may be more restrictive than the V_{max} rule. For example, a single point alignment deviation that measures 1⅞ inch in Class 3 track may impose a greater speed restriction than the V_{max} rule. Under the V_{max} rule, the maximum speed on a curve is determined by averaging both the curve alignment and crosslevel measurements for 10 points (establishing 11 stations, 5 on either side of the point of collision) at 15½-foot spacing. A curve's elevation and the amount of curvature for each 155-foot track segment is calculated by the geometry car and produces a limiting speed using the V_{max} formula.

Curve speed calculated by ATIP cars are to be strictly enforced. For instance, if the calculated speed of a curve is 46 mph, speeds above 46 mph are not compliant. The reasoning for the strict interpretation is the allowance (compromise) of averaging elevation and curvature versus the more restrictive point-to-point method. In the body of the curve, an average of both the alignment and crosslevel measurements through 155-foot of track segment is a regulatory requirement and formula calculations are necessary to know the maximum authorized speed. The "average" approach recognizes the "steady-state" purpose of the formula.

If the length of the body of the curve is less than 155 feet, measurements should be taken for the full length of the curve body. Transient locations (point to point) are addressed by the alignment and track surface tables, a departure from the present averaging measurement technique.

The difference between the track angle and the car angle is called the roll angle. The less the roll angle, the better the comfort and safety obtained going around the curve. Although 4 inches of cant deficiency is usually applied to passenger trains, other types of equipment with comparable suspension systems, centers of gravity, and cross-sectional areas may perform equally well. Inspectors should be familiar with the different types of rail equipment operating over their assigned territory.

Inspectors may use Equation 1 to solve for unbalance:

$$U_b = E_a - ((V^2 \times D) \div 1{,}430) \qquad (1)$$

Where:

U_b = Unbalance

E_a = Average Elevation

V^2 = Velocity Squared

D = Average Degree of Curvature

ATIP cars indicate the maximum allowable speed in the TGIR and list the condition as an exception. Inspectors will not usually consider recommending violations when the calculated operating speed produces marginal differences (the ⅓ unbalance rule) above the approved unbalanced level. At locations where minimal Superelevation and curvature produce more than 3 inches but less than 4 inches of unbalance, the TGIR lists the exception for correction—no violation is usually recommended. For example, a 3-inch unbalance exception would include values of elevation (E_a) 4⅛ inches, curvature (D) 2¾ degrees, and the designated train speed (V) is 50 mph. Calculating the values U_b = 4⅛ – ([50×50×2¾] ÷ 1,430) equals 3⅝ (3.625) inches [21 percent more, but less than 33 percent]) of the 3 inches of unbalance allowed.

Inspectors' knowledge is important regarding the various types of freight and especially that the operating passenger equipment and associated unbalance levels are authorized within their respective regions. Where FRA has approved certain equipment types for curving speeds producing more than 4 inches of unbalance and specific locations confirm operating speed on curves creates more than 33 percent (1⅜ inches) more unbalance, and if the railroad has not initiated remedial action, Inspectors will consider recommending a civil penalty. For example, a 4-inch unbalance violation would include values of elevation (E_a) 2 inches, curvature (D) 3.125 degrees, and the designated train speed (V) is 60 mph. Calculating the values U_b = 2 – ([60×60×3.125] ÷ 1,430) equals 5⅞ inches (1⅞ inch or 47 percent more) of the 4 inches of unbalance allowed.

Geometry Car Security

Track Inspectors are responsible for proper security of the ATIP car and must use good judgment and discretion in the application and placement of protective devices and train control signs (e.g., red or blue flags), as circumstances warrant. To prevent undesired access when the geometry car is unoccupied, FRA Inspectors will ensure contractor personnel always provide protective measures. FRA Inspectors will notify both regional and HQ staff if conditions exist that do not allow protective devices to be applied.

Highway-Rail Grade Crossings

All occupants in the controlling compartment of the geometry car are responsible for ensuring the way is clear when approaching highway-rail grade crossings equipped with either passive or automatic warning signal system devices as detailed below:

1. The rate of deceleration on self-propelled geometry cars must be controlled to speeds deemed appropriate, based on the local conditions (e.g., gradient, visibility, individual rail surface stopping conditions) and approach a highway-rail grade crossing at reduced speed, be prepared to stop, if necessary, until it is known that automatic warning devices actuate,
2. If signal system failures disrupt the proper function of the warning devices, the occupants must be able to respond immediately,
3. The railroad representative reports warning system malfunctions to the Dispatcher according to 49 CFR Part 234, and
4. Take precautions not to interfere with the normal function of the automatic warning signal system devices. The exception to this is on condition that proper flag protection against highway vehicles is provided by railroad or contractor personnel when automatic warning devices fail to fully activate or when the host railroad's rules require an exception, Part VI of the FRA Manual on Uniform Traffic Control Devices provisions, or FRA regulations.

Reports

Document and Data Control

To ensure ATIP reports are delivered to those persons FRA authorizes, the Survey Director only delivers the TGIR reports to FRA Track Inspectors. It is the responsibility of the FRA Track Inspector to authorize distribution of a sufficient quantity of reports (paper or electronic) to the railroad representative on board. Additionally, the Survey Director enters into the survey log the name, contact information, and the number of reports the railroad representative receives. The survey log is retained and kept on file with the daily survey documentation.

FRA Track Inspection Report

Inspectors are to prepare an FRA Track Inspection Report (Form F 6180.96) for each ATIP survey with appropriate source codes and the survey number. See Chapter 2 of this manual for instructions on preparing Form F 6180.96. Inspection surveys may involve multiple reports on a given day. Inspectors may complete multiple 96 report forms and assign among themselves different railroads surveyed during the day and reinspection activities. To avoid duplication and distorting the FRA database, only one 96 report form will be completed for each survey segment or railroad, even though more than one Inspector may be on board.

Source Code

I **ATIP ACTIVE AND INACTIVE SURVEYS**

Use Source Code I with the reporting marks of the railroad followed by an Office of Safety assigned ATIP survey file number, e.g., XXXX_0123. Source code I will be used when inspecting track in conjunction with ATIP active surveys. The report header on the 96 report form is to be filled out during this inspection activity and exception(s) listed by the geometry car are to be appended and recorded on the 96 report form line items. Enter all units of inspection in the activity code box. Ensure that the survey miles accurately correspond (verified by the Survey Director) with the daily number of miles operated by the geometry car. When conducting an inactive survey, use Source Code I, but list only the mileage operated by the geometry car.

J ATIP FOLLOWUP REINSPECTION

Use the ATIP number corresponding to the original survey files number (e.g., alpha-numeric XXXX_0123) assigned by the Office of Safety. Followup inspections should be conducted within 30 days. Also, if the ATIP car is stopped for verification during an active survey and noncompliance conditions are cited, the Inspector must initiate a Source Code J report separate from the Source Code I report mentioned above.

When conducting ATIP followup inspections (Source Code J), if track exceptions other than those reported by the geometry car are discovered, then another 96 report form with the appropriate source code must be completed. Do not combine ATIP exceptions with other exceptions on one 96 report form.

N ATIP INSPECTION OF STRACNET

The strategic rail corridor network (STRACNET) is a network of military routes important to national defense. Paper and electronic State maps are available to help identify these important routes.

End of Chapter 3

Appendix: Conversion Feet to Decimals of a Mile

Milepost Increasing up in feet	Decimal Mile	Fractional Mile	Poles	Fractional Mile	Down Feet	Milepost Decreasing Decimal Mile
0	0.000	0	0	1	0	0.000
132	0.025		1		-132	0.975
264	0.050		2		-264	0.950
396	0.075		3		-396	0.925
528	0.100		4		-528	0.900
660	0.125	⅛	5	⅞	-660	0.875
792	0.150		6		-792	0.850
924	0.175		7		-924	0.825
1056	0.200		8		-1056	0.800
1188	0.225		9		-1188	0.775
1320	0.250	¼	10	¾	-1320	0.750
1452	0.275		11		-1452	0.725
1584	0.300		12		-1584	0.700
1716	0.325		13		-1716	0.675
1848	0.350		14		-1848	0.650
1980	0.375	⅜	15	⅝	-1980	0.625
2112	0.400		16		-2112	0.600
2244	0.425		17		-2244	0.575
2376	0.450		18		-2376	0.550
2508	0.475		19		-2508	0.525
2640	0.500	½	20	½	-2640	0.500
2772	0.525		21		-2772	0.475
2904	0.550		22		-2904	0.450
3036	0.575		23		-3036	0.425
3168	0.600		24		-3168	0.400
3300	0.625	⅝	25	⅜	-3300	0.375
3432	0.650		26		-3432	0.350
3564	0.675		27		-3564	0.325
3696	0.700		28		-3696	0.300
3828	0.725		29		-3828	0.275
3960	0.750	¾	30	¼	-3960	0.250
4092	0.775		31		-4092	0.225
4224	0.800		32		-4224	0.200
4356	0.825		33		-4356	0.175

Milepost Increasing up in feet	Decimal Mile	Fractional Mile	Poles	Fractional Mile	Down Feet	Milepost Decreasing Decimal Mile
4488	0.850		34		-4488	0.150
4620	0.875	⅞	35	⅛	-4620	0.125
4752	0.900		36		-4752	0.100
4884	0.925		37		-4884	0.075
5016	0.950		38		-5016	0.050
5148	0.975		39		-5148	0.025
5280	1.000	1	40	0	-5280	0.000

Legend for Railroad Delays	
PS	Passenger Stop (Boarding or Detraining Personnel
RB	Red Block (Priority Dispatching other Trains in CTC Territory: Signal Malfunction)
MD	Mandatory Directives Dispatching Territory (TWC, DTC, Form D, Traffic, etc.)
P1...Px	(Unqualified, Unassigned Crew Call or Late Reporting, etc.)
TS Ev	Track Structure (Unsafe Geometry, Special Trackwork; Clearance; Excessive Vegetation, Ballast, etc., or Obstruction)
GX	Grade Crossing, Signal, or other Shunting Failures
Legend for ENSCO Delays	
G1	Primary Gage System
G2	Secondary Gage System
C1	LVDT
C2	RVDT
C3	CAS Package
P1	Profile Accelerometer Left
P2	Profile Accelerometer Right
RQ1	Ride Quality Car Body Vertical
RQ2	Ride Quality Car Body Lateral
RQ3	Ride Quality Truck Lateral
PT	Paint
CN	Computer or Printer Network
P (E,F,R)	Onboard Personnel Induce (ENSCO, FRA, or Non-Operating Railroad)
T	Tachometer Failure
E1	Engine One Generated Failure
E2	Engine Two Generated Failure
Environmental Delay Legend	
W	Weather-Related: (Any Material {Water Over Top of Rail, Blowing Snow, Leaves, Etc.}