

## **NOTICE OF SAFETY ADVISORY 2001-01 - Recommended minimal guidelines for the operation of remote control locomotives.**

On February 14, 2001, FRA published Notice of Safety Advisory 2001-1 in the Federal Register (Volume 66, No. 31, page 10340), addressing the establishment of recommended minimal guidelines for the operation of remote control locomotives.

**Background:** Remote control locomotives (RCL) have been in use for a number of years. The term "remotely controlled locomotives" or "remote control locomotives" refers to a locomotive which, through use of a radio transmitter and receiver system, can be operated by a person not physically located at the controls within the confines of the locomotive cab. (As used in this document, the term "remote control locomotive" does not refer to use of distributive power, in which a locomotive or group of locomotives entrained or at the rear of a train is remotely controlled from the lead locomotive of a train).

FRA's first priority in assessing RCL operations is to ensure that these operations pose no threat to railroad workers or the general public. Because this technology is not widely used in railroad operations, FRA has limited data on which to base an objective safety analysis and must therefore proceed prudently. It is clear that the potential for serious injury exists, as it does in all aspects of railroad operations. RCL operations have been in existence in this country for many years; however, this technology has largely been confined to in-plant rail operations. As these operations expand, some of the traditional ways of conducting rail movements will be significantly modified. Under such circumstances, safety risk factors may change. It is FRA's task to ensure that this transition takes place safely. Throughout its history, FRA has tried to encourage and embrace technological advances in the rail industry.

In 1994, FRA proposed to conduct a national test program of RCL operations. FRA held a hearing on February 23, 1995 (FRA Docket No. 94-6), to gather testimony on the proposed RCL operating conditions. See 59 FR 59826 (November 18, 1994). Several manufacturers, labor organizations, railroads, and their associations participated in the hearing. The testimony provided by these organizations revealed a broad spectrum of opinion concerning the merits of the proposed program, the substance of the program requirements, the resultant risks to railroad employees, and the safety of the technology.

Interest in, and use of RCLs by the railroad industry has intensified since publication of the Notice of Test Program and the 1995 public hearing. FRA believed that RCL technology has progressed beyond the "test" period and proposed one final meeting to obtain the most recent information and comments on this technology. On July 19, 2000, FRA held a technical conference to allow all interested parties the opportunity to state their concerns and opinions on RCL operations. The conference examined all safety aspects of RCL operations, including (1) Design standards, (2) employee training, (3) operating practices and procedures, (4) test and inspection procedures, and (5) security and accident/incident reporting procedures.

The following is a brief discussion of the material and comments presented at that conference. Several commentors expressed concerns in the following areas: RCL operations in bad weather conditions, ergonomic issues in the design of the remote control transmitter (RCT), electromagnetic field (EMF) emissions from RCTs, insufficient clearance when wearing the RCTs in tight spaces, roadway worker protection issues, mental and physical stress associated with RCL operation, and lack of accurate exposure metrics for calculating accident rates.

Conversely, several commentors stated that RCL operations have enhanced safety performance. Some of the suggested enhancements included better visual contact with the leading end of rail movements, the elimination of communication error between the locomotive engineer and ground crew, and the reduction of yard accidents and injuries. Several commentors submitted data that indicate accidents and incidents dropped dramatically as RCL operations increased. Although FRA commends these commentors for their efforts in gathering such data, FRA notes that the data used were obtained without equal exposure metrics to allow valid comparisons between remote control and manual operations (i.e., comparisons were not equalized for the number of labor hours and number of employees). Normalizing safety data is necessary to clarify our understanding of the potential safety risks.

Consequently, FRA is taking steps to incorporate RCL operations into the accident/incident reporting procedures required by 49 CFR part 225. See 65 FR 79915, December 20, 2000. FRA is proposing to modify the instructions for Forms F 6180.54, 6180.55a, and 6180.57 in its Guide to Preparing Accident/Incident Reports. Two of the three form modifications will request that the "Special Study Block" (SSB) of each form be used to capture (with coded letters) information pertaining to accidents/incidents which involve RCL operations. The third form will capture the required data with an annotation in the narrative portion of the form.

In addition, FRA recommends that railroads maintain appropriate exposure measures, including total number of labor hours and total number of employees by location for both RCL operations and manual locomotive operations. Together these measures will allow FRA to accurately measure accident and incident rates of both types of operations and make valid comparisons between RCL operations and manual operations. Thus, the railroads will be able to closely monitor the safety performance of RCL operations as they progress. FRA will then use these data when considering any future policies on these operations.

FRA notes that many of the ergonomic design concerns experienced by remote control operators (RCOs) have been addressed in the current generation of RCTs. FRA commends the rail industry and RCL system manufacturers for their diligence in addressing the design concerns of RCOs. As this new technology expands, the continued input of the men and women who operate RCLs will be necessary to ensure that ergonomic issues and operating concerns are properly identified and fully addressed, consistent with the needs of both RCOs and the rail industry. Furthermore, we must be cognizant that gender specific issues may arise with respect to ergonomic challenges and solutions. FRA will, therefore, recommend that railroads give special consideration to the unique human/machine interface problems that may arise during the proliferation of this technology,

particularly regarding female operators.

FRA has reviewed the furnished data concerning fatalities that have occurred during RCL operations on plant railroads. The data indicate that none of these fatalities occurred as a direct result of RCL system failure. All involved the same scenarios described in similar fatalities that have occurred during manual switching operations. There was no way to determine if these workers were distracted due to their added responsibility of conducting RCL operations. However, FRA will attempt to reduce possible risk by recommending that RCOs (1) Should not ride on rail cars, (2) should not mount or dismount from moving locomotives during RCL operations, and (3) should remain well clear of affected tracks when in front of a locomotive movement. FRA also believes that additional training should be provided to traditional locomotive engineers who will be required to operate RCLs and who have never worked on the ground during switching operations. These individuals lack the valuable experience gained from working around moving equipment and are less likely to recognize dangerous situations.

FRA believes that bad weather conditions, roadway worker protection procedures, RCT clearance problems, and mental and physical stress issues are operational problems that can and do occur during any railroad operation and are best addressed through proper training and through a credible communication system. There should be a direct line of communication between labor and management to quickly address RCL operating problems and training needs. Therefore, FRA recommends that a formal communication procedure should be developed to ensure that RCL operational concerns are handled expeditiously.

In response to concerns expressed by a number of parties, FRA had previously asked DOT's Volpe Center to test the electromagnetic radiation (EMR) emissions from an RCL system, simulating realistic rail yard operating conditions (since multiple reflections of radiofrequency radiation from metallic surfaces, like railcars, can enhance the primary beam and cause hotspots). An independent test contractor then tested EMR levels according to FCC standards and found that under normal use and where the manufacturer's operating instructions were followed, EMR emissions and workers' exposure levels were in full compliance with applicable human exposure safety standards regarding radio frequency radiation.

FRA found no data that would indicate that electromagnetic field (EMF) and EMR emissions from RCTs exceed the accepted human exposure safety standards in the United States. FRA and the DOT Volpe Center technical experts will, however, continue to monitor the latest studies on potential health effects from long term low level environmental and work EMF and EMR exposures, as well as up-to-date applicable Occupational Safety and Health Administration (OSHA) standards posted on the web at <http://frwebgate.access.gpo.gov/cgi-bin/leaving.cgi?from=leavingFR.html&log=linklog&to=http://www.osha-slc.gov/SLTC/radiofrequencyradiation>. Standards and practices addressing EMF and EMR emissions can also be found in: FCC, 1997 Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields," FCC Office of Engineering Technology (OET), Ed. 97.01, FCC Bulletin 65, August 1997 and Supplement C, December 1997. Both items are posted

on the web at

<http://frwebgate.access.gpo.gov/cgi-bin/leaving.cgi?from=leavingFR.html&log=linklog&to=http://www.fcc.gov/oet/rfsafety>; IEEE, C95.1a-1988, "IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 KHz to 300 GHz," Edition 16 and Supplement a, April 1999, to be ordered from IEEE Customer Service at 1-800-678-IEEE; and the "American Conference of Governmental Industrial Hygienists (ACGIH)," TLVs and BEIs-Threshold Limit Values for Chemical Substances and Physical Agents," pp. 150-155 (See <http://frwebgate.access.gpo.gov/cgi-bin/leaving.cgi?from=leavingFR.html&log=linklog&to=http://www.ecgih.org>). FRA intends to ensure that the margin of safety is maintained in this area and will take appropriate action if it becomes apparent that accepted safety margins are not maintained or if credible data on potential worker safety or health hazards from such exposures become available.

A review of the accident/incident reports submitted during the technical conference disclosed communication failures, speed surges, braking force problems, and emergency stops during RCL operations. However, most of the reports were dated between 1996 and 1997 and pertained primarily to one rail yard and to a specific group of RCLs in that yard. FRA believes that current generation of RCTs have addressed many of the reported problems with RCL systems. It has been FRA's experience that, as this type of technology is introduced into railroad operations, unforeseen problems in hardware and software design do develop. As a consequence, FRA suggests that railroads have procedures in place to immediately identify and address such problems to reduce the risk of accident and/or injury. In addition, the FRA suggests that railroads have scientifically valid data gathering procedures to accurately monitor accident rates in RCL operations compared with manual locomotive operations.

FRA has also reviewed data from the Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) regarding any accidents investigated involving RCL operations. The records indicate that there has been considerable concern by OSHA regarding protection of rail movements. The records cite incidents of inplant rail movements that were not properly protected in the direction of travel, i.e., RCOs were not in position to observe the track ahead of the movement. MSHA also reported an accident that was caused in part by "the inability of the remote operator to see the locomotive." These concerns are not new to the rail industry, which has long adopted operating rules that require switching movements to be made at a speed that will enable the movement to stop within half the range of vision short of a train, an engine, a railroad car, people or equipment fouling the track, obstructions, a stop signal, or a derail or switch lined improperly (restricted speed). Simply put, no movement should begin unless the track ahead of that movement is known to be clear. This would require RCOs to view the track ahead of the movement each time a movement is made. Because FRA believes RCL operations will be primarily conducted within heavily congested areas, i.e., railroad yards, and because FRA wishes to ensure that these operations are conducted in the safest possible manner, FRA recommends that all RCL movements be conducted at restricted speed, unless specifically exempted by railroad special instructions. However, these special instructions should ensure that a comparable means of protection is afforded these movements. FRA notes that many railroads have limited exemptions from the provisions of restricted speed. FRA plans to

closely monitor how railroad operating rules are modified to accommodate RCL operations. Safety must not be compromised by these modifications. FRA also plans to monitor the accident/incident rates in areas where RCL operations exist to ensure that safety is maintained.

FRA notes that traditional railroad industry restricted speed rules or their equivalents were not developed to protect trespassers or railroad workers who are not authorized to be on the track. Therefore, in the interest of safety, FRA will recommend that the public and railroad workers in the area should be notified by clearly visible warning signs, or by other equally effective means, that RCL operations exist and train movements are being conducted without anyone in the locomotive.

FRA is also concerned about RCO safety when operations are conducted in isolated areas. There is no assurance that emergency aid can be adequately provided in a timely manner in the event of an emergency situation. Therefore, FRA recommends that the railroad or RCT should provide some automatic means of communication that will notify the railroad in the event the RCO becomes incapacitated, i.e., "a worker alarm". This automatic communication feature should also be capable of determining the non-responsive RCO's location to ensure that emergency help can respond effectively.

Part 240 of title 49 of the Code of Federal Regulations requires that all individuals who operate a locomotive are to be qualified and certified in accord with the requirements of that regulations. Therefore, anyone who operates a locomotive, regardless of the means used, must be properly trained and certified. The introduction of remote control operations is a significant departure from traditional on-board locomotive operations. If a railroad elects to conduct RCL operations, its locomotive engineer certification program would have to be modified to outline the training that will be required for this type of operation. This would constitute a material modification of the program requiring that the program be submitted to FRA for approval according to 49 CFR 240.103(e).

Because information currently available to FRA does not lead to the conclusion that RCL operations should be prohibited on safety grounds, FRA has elected to proceed cautiously. The range of views and safety concerns expressed underscores the need to proceed with the implementation of this new technology in a safe and consistent manner. The Safety Advisory announced today is a refinement of proposed standards contained in the original Test Program.

**Recommendation:** The following design criteria and operating procedures are recommendations only. Compliance is voluntary. However, railroads are strongly encouraged to regard these suggested criterion as a minimum from which to tailor their own RCL operations. It should be noted that all of the design features recommended are available with the current generation of remote control technology. In certain circumstances, due to the design of their equipment, or differences in operating practices, a railroad may not be able to obtain complete consistency with these recommendations. In those situations railroads are encouraged to develop alternative designs or practices which offer at least equivalent or greater levels of safety. FRA emphasizes that although

compliance with this Safety Advisory is voluntary, nothing in this Safety Advisory is meant to relieve a railroad from compliance with all existing railroad safety regulations. Therefore, when procedures required by regulation are cited in this Safety Advisory, compliance is mandatory.

#### A. Safety Design and Operational Requirements

- Each RCT should, at a minimum, have the following features:
  1. directional control;
  2. graduated throttle or speed control;
  3. graduated locomotive independent brake application and release;
  4. train brake application and release control;
  5. audible warning device control (horn);
  6. audible bell control, if equipped;
  7. sand control (unless automatic);
  8. headlight control;
    - i. emergency air brake application switch;
    - j. generator field switch or equivalent to eliminate tractive effort to the locomotive; and
    - k. audio or visual indication of wheel slip/slide.
- 2. Although an RCT can have the capability to control, at different times, different locomotives equipped with remote-control receivers, it should be designed to be capable of controlling only one RCR equipped locomotive at a time. (A locomotive may consist of one or more engines operated from a single control).
- 3. An RCT having the capability to control more than one RCL should have a means to lock in one RCR "assignment address" to prevent simultaneous control over more than one locomotive.
- 4. Each locomotive equipped with an RCR should respond only to the RCTs assigned to that receiver.
- 5. The RCT should be designed to require at least two separate actions by the RCO before RCL movement can begin (in order to prevent accidental movement).
- 6. When an RCT's signal to the RCL is interrupted for a set period, not to exceed five seconds, the remote-control system should cause:
  - a. full service application of the locomotive and train brakes; and
  - b. elimination of locomotive tractive effort.
- 7. If an RCT is equipped with an "on" and "off" switch, the switch, when moved from "on" to "off" position, should result in:
  - a. application of the locomotive and train brakes; and
  - b. elimination of locomotive tractive effort.
- 8. Each RCL should have a distinct and unambiguous audible or visual warning device that indicates to nearby personnel that the locomotive is under active remote control and subject to movement.
- 9. Each RCT should be equipped with an operator alertness device requiring manual resetting or its equivalent. It should incorporate a timing sequence not to exceed 60 seconds. Failure to reset the switch within the timing sequence should result in:

- a. application of the locomotive and train brakes; and
  - b. elimination of locomotive tractive effort.
10. Each RCT should have a tilt feature that, when tilted to a predetermined angle, should result in:
- a. an emergency application of the locomotive and train brakes; and
  - b. elimination of locomotive tractive effort.

Note: If RCL operations are being conducted in an isolated area, the railroad should establish timely emergency response procedures in the event the RCO is incapacitated. One method that would serve to meet this recommendation would be to equip the RCT with capability of transmitting an emergency signal. The signal should also be capable of identifying the RCO's location.

11. If the RCT is equipped with a "tilt bypass" system enabling the tilt protection feature to be temporarily disabled, the bypass feature should deactivate after 15 seconds, unless reactivated by the RCO.
12. The RCL should be equipped with a device that causes an application of the locomotive and train brakes and elimination of locomotive tractive effort whenever the RCL's main reservoir air pressure falls below 90 psi or when a locomotive protection alarm is activated while the locomotive is in remote operation. The device should need to be manually reset on board the RCL.
13. When the air valves and the electrical selector switch on the RCR are moved from manual to remote or from remote to manual modes, an emergency application of the locomotive and train brakes should be initiated to prevent unauthorized use of the system.
14. Railroads which acquire and utilize RCL equipment should comply with current human safety exposure standards for radio frequency radiation in their workplace. FRA further recommends that manufacturers should certify their equipment for compliance with current EMR exposure safety standards.
15. Consideration should be given to the design of the RCT to provide for a human-machine interface (HMI) that incorporates basic human factors principles for the design and operation of displays, controls, supporting software functions, and other components. FRA recommends that railroads work closely with RCOs when addressing RCT design and comfort issues. The overriding goal of the design should be to minimize the potential for design-induced error by ensuring that the RCT is suitable for operators, including female operators, and their tasks and environment. RCT systems that have been designed with human-centered design principles in mind--system products that keep human operators as the central, active component of the system--are more likely to result in improved safety. This includes the ergonomic design of the RCT. See FRA's 1998 report entitled "Human Factors Guidelines for Locomotive Cabs" (FRA/ORD-98/03 or DOT-VNTSC-FRA-98-8). Special consideration should be given to the effect of the RCT on the musculoskeletal system of the RCOs as well as on RCT harness comfort to avoid distraction from safety-related duties. Additional consideration should also be given to the "breakaway" safety feature of the RCT harness. The harness should be designed to easily break free of the RCO in the event the harness becomes entangled on equipment.

## B. Training

Each person operating an RCL must be certified and qualified in accordance with 49 CFR Part 240 if conventional operation of a locomotive under the same circumstances would require certification under that regulation. Training must be provided to all RCOs subject to the requirements of 49 CFR Part 240. Additionally, training should be afforded those RCOs not subject to the requirements of Part 240 and those locomotive engineers who have little or no on-ground experience in switching operations if they are expected to conduct RCL operations.

All affected railroad employees should be trained on RCL operating rules and procedures.

Under Part 240, railroad engineer certification programs must include procedures to keep certified engineers current on methods of safe train handling, operating rules, condition of equipment, and personal safety and to provide initial training for new engineers on those subjects. Sec. 240.123. The programs must also include skill testing in the most demanding type of service the person will perform. Sec. 240.127. Appendix B of Part 240 requires that railroad engineer certification programs address how the railroad responds to changes such as the "introduction of new technology" and "significant changes in operations." In FRA's view, it is likely that the introduction of remote controlled locomotives on railroads would typically necessitate a material change to each railroad's engineer certification program. Material modifications must be submitted to FRA for its review under 49 CFR 240.103(e).

## C. Operating Practices

1. The railroad should establish written standard operating procedures tailored to its RCL operations. At a minimum these procedures should include:
  - a. Upon going off duty, each RCO should place the RCL in manual operation and properly secure it, unless control of the RCL is directly given to a relieving RCO.
  - b. When operating an RCL, the RCO should not:
    - i. ride on a freight car under any circumstances;
    - ii. mount or dismount moving equipment;
    - iii. operate any other type of machinery; or
    - iv. stand or walk within the gage of the track or foul the track on which the movement is occurring while physically located in front of the movement.
  - c. RCOs should ensure that the track is clear and properly aligned ahead of the remotely controlled movement while it is underway. Therefore, RCL operations should be operated at restricted speed not to exceed 20 mph, i.e., at a speed that will enable stopping the movement within half the range of vision assuring that all movements are protected.
  - d. The RCO should operate only one RCL at a time.
  - e. Prior to performing any function as prescribed in 49 CFR 218.22(c)(5), the RCO should apply three point protection, i.e., fully apply the locomotive and train brakes, center the reverser, and place the generator field switch to the off position (eliminate locomotive tractive effort capability).
  - f. Passenger trains should not be operated by use of a remote-control device.



2. The railroad must include RCL operating rules and procedures in its program required under 49 CFR part 217.
3. The railroad should establish formal communication procedures to enable the appropriate railroad officials to receive and respond to information pertaining to RCL system failures or safety problems.
4. The FRA recommends that the railroad keep a record of the total number of labor hours and the total number of employees by location for both RCL and manual switching operations to ensure that accidents and incidents are accurately measured, and that valid comparisons between the two types of operations can then be made.
5. The FRA recommends that the railroad develop and implement a program specifically designed for RCOs that addresses the risks associated with switching operations and train movements on adjacent tracks. This program should incorporate the findings and recommendations of the Switching Operations Fatality Analysis Working Group.

#### D. Security

1. The railroad should have instructions for the proper storing and handling of RCTs when not in use or in the operator's possession.
2. The operation control handles located in the RCL cab should be removed or pinned in place to prevent accidental or intentional movement while the RCL is being operated in remote.
3. The railroad should have strict procedures in place to ensure that only the intended RCTs are assigned to the appropriate RCL.

#### E. Inspections and Tests

1. The RCL system must be included as part of the calendar day inspection required by 49 CFR 229.21, since this equipment becomes an appurtenance to the locomotive.
2. Each time an RCT is used for the first time on each shift, a test of the air brakes and the RCT's safety features (tilt switch and alerter device) should be conducted. The test would not be required if the RCT were being directly transferred from one RCO to another with no change in remote status.
3. The RCL system (both the RCT and RCR), should be designed to perform a self-diagnostic test of the electronic components of the system. The system should be designed to immediately "fail safe" (full service application of the locomotive and train brakes and the elimination of locomotive tractive effort) in the event a failure is detected.
4. The RCL system components that interface with the mechanical devices of the locomotive, e.g., air pressure monitoring devices, pressure switches, speed sensors, etc., should be inspected and calibrated as often as necessary, but not less than the locomotive's periodic (92-day) inspection. It is recommended that records of such inspections and calibrations be kept.

#### F. Notification of RCL Use and Protection of Workers

1. Each RCL should have a tag placed on the control stand throttle indicating the locomotive is

being used in a remote control mode. The tag should be removed when the locomotive is placed back in manual mode.

2. In areas where RCL operations are being conducted, warning signs should be posted indicating that there is no operator in the control compartment of the locomotive. These warning signs should be highly visible and posted at conspicuous locations so as to maximize their exposure to those most likely to encounter RCL operations.
3. Whenever worker protection is required according to 49 CFR part 218, the locomotive should be placed into manual mode and be properly secured. The appropriate blue signal protection should then be provided.

#### G. Accident-Incident Reporting Procedures

1. All accident and/or incidents described in 49 CFR part 225 must be reported to FRA using the appropriate "remote control" reporting codes.
2. Railroads are also reminded that they are required to comply with the provisions of 49 CFR part 229.17--Accident reports.

Issued in Washington D.C. on February 1, 2001. Edward R. English, Director, Office of Safety Assurance and Compliance.