



United States Operations

Transmission Operations Procedure TOP-18

Post Interruption Line Patrols

Authorized by

A handwritten signature in black ink, appearing to read "John Spink", written over a horizontal line.

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1.0 Change Control

Rev.	Date	Modification	Author(s)	Reviews and Approvals by
1.0	7/1/2010	Initial	J.M.McGrath	N.E.Hitti
2.0	7/10/2013	Added a definition of Jointly Owned Lines in 3.0. Modified patrol initiation requirements in 6.4. Clarified requirements when patrolling jointly owned lines or patrolling lines for other utilities in 7.4. Deleted reference to ISO New England Operating Procedure No. 3, Transmission Outage Scheduling: Attachment B – ISO New England Standard 115kV and Above.	Changes submitted by Will Houston, Nickolas Gibson and Michael Schiavone	John Spink

This document should be reviewed initially at 1 year and then at least every 2 years

2.0 Introduction

2.1. Purpose

The purpose of this procedure is to outline the requirements for Post Interruption Line Patrols associated with all circuit Interruptions on National Grid USA Transmission circuits. The Patrol method utilized and the timing of Patrols will be specified based on type of circuit, type of interruption, system demands, and through consultation between the Transmission Control Center (TCC) and In House Construction.

This procedure calls for TCC to obtain all necessary information and document in IDS per Attachment B. Information shall be timed to allow for effective communication to In House Construction *prior to patrolling*.

2.2. Applicability

This procedure applies to all circuit Interruptions, both momentary and sustained, on all overhead line equipment managed by National Grid US Transmission as defined by Transmission Group Procedure 12 (TGP 12).

3.0 Definitions

Circuit, Bulk – Transmission circuits connected to stations determined to have bulk power status per the criteria in NPCC Document A10. These locations are where faults or disturbances can have a significant adverse impact outside of the local area. A list of bulk power stations is maintained by Transmission Planning and made available to departments requiring it.

Circuit, Load – Transmission circuits not considered bulk

Circuit, Transmission – New England - 69kV and above - New York 115kV and above.

Circuit Interruption – One or more openings of a protective device (circuit breaker, circuit switcher, etc.) that results in zero voltage or discontinuity on a circuit, or on adjacent connected facilities. A Circuit Interruption could be caused by a Fault, system conditions or a Misoperation.

Circuit Interruption, Momentary - A Circuit Interruption where the protective devices successfully re-close, whether automatically or in some cases manually, restoring the circuit to normal service without any field actions being taken.

Circuit Interruption, Sustained – A Circuit Interruption where the protective devices do not successfully re-close and the circuit remains out of service.

Digital Fault Recorder (DFR) – A device that captures system conditions immediately prior to and after system interruptions. Can be used in some circumstances to provide Distance to Fault Data.

Distance to Fault (DTF) Data – An estimate of the distance from a source substation to a Fault that is calculated by a type of microprocessor protective relay or DFR. The accuracy of this information will vary depending on circuit configuration.

FALLS (Fault Analysis and Lightning Location System) – Tool used by TCC to pinpoint the approximate location of a lightning strike

Fault – A deficiency that causes a Circuit Interruption

Jointly Owned Lines – Lines where one or more sections are owned by another utility.

Misoperation – A Circuit Interruption that takes place when system conditions (i.e. Fault or loading status) do not warrant the interruption

Field Patrol Lead – A person designated to coordinate and be responsible for a Patrol and its Patrollers in the field as well as be the official communication link to TCC

Patrol – A visual inspection of equipment specifically performed to find the location of a Fault after a Circuit Interruption

Patroller – Personnel qualified and assigned to identify a Fault via aerial or ground based visual Patrols after an interruption

4.0 References

4.1. Developmental References

None

4.2. Performance References

New England Control Center/ REMVEC II Transmission Operations – Operating Procedure 98 – General Procedures for Transmission Line Patrols

New England Control Center/ REMVEC II Transmission Operations – Operating Procedure 99 – Re-closing Guidelines

New York Control Center Policies and Procedures 10.8 – Targeting Patrols

New York Control Center Policies and Procedures 12.1 – Flashing Transmission Lines

New York Control Center Policies and Procedures 12.4 – Helicopter patrol Notifications

New York Control Center Policies and Procedures 12.5 – Reenergizing Guidelines

Niagara Mohawk WRCC Memos and Procedures: Section 14: Topic 14.10: Flashing Transmission Lines

Transmission Line Inspection and Maintenance Specification, SP.06.01.601.000

Transmission Aerial Visual Inspection Procedure, PR.06.01.601.002

Transmission Ground Based Visual Inspection Procedure, PR.06.01.601.001

National Grid Employee Safety Handbook

Substation Maintenance Procedure SMP400.87.2 – Emergency Response Before Re-Energization

Transmission Performance Trend Identification and Response Procedure, TOP-17

5.0 Responsibilities and Expectations

5.1. All Users

Transmission Control Center (TCC)

- Take lead role during interruption events
- Initiate all appropriate notifications
- Coordinate Post Interruption Line Patrol
- Gather and document pertinent data in IDS and communicate to the Field Patrol Lead per Attachment B
- Operate system, including safe reenergization of equipment

T&D Performance Reporting

- Gather and document pertinent data in IDS and communicate to the Field Patrol Lead per Attachment B

In House Construction

- Supply Field Patrol Lead
- Determine safe conditions for Patrol
- Determine type of Patrol
- Perform Post Interruption Line Patrols
- Perform post fault repairs

Substation Operations

- Inspect substations
- Gather all pertinent post interruption substation data including breaker operation counts, relay and DTF data

Protection Standards and Support

- Supply protective relay training information
- Perform guidance and analysis on DTF operation and accuracy
- Interpret data from Digital Fault Recorders (DFR)
- Supply list of DTF locations

Transmission Line O&M Engineering

- Provide guidance and support for the execution of the Post Interruption Line Patrol program
- Provide guidance on exceptions

6.0 Procedure – Pre-Patrol

6.1. Actions Immediately Following Interruption

System Information immediately available is to be gathered by TCC and documented in IDS per Attachment B.

In House Construction shall be notified of all interruptions caused by, or potentially caused by, line equipment, regardless of the need for a Patrol. Substations, Underground or Relay personnel should be notified of all interruptions caused by their respective equipment.

Timing of notifications, station inspections and ultimately the patrol may be affected by criticality, system conditions, volume of interruptions and other factors. It should be noted that all steps in this procedure should be completed as soon as possible following the Circuit Patrol Criteria below whenever possible.

All pertinent information should be obtained and communicated to the Field Patrol Lead *prior to the Patrol* by TCC per Attachment B. In circumstances where this is not practical, the Field Patrol Lead should be informed what information is missing. Any missing information should be communicated to the Field Patrol lead as soon as it is received.

6.2. Fault Indicators

Any fault indicators outside of substations shall be checked by In House Construction with target data relayed to TCC. Local Distribution personnel such as Troubleshooters or Substation personnel may assist with this activity. This information shall be documented in IDS per Appendix B. TCC can assist with the location information of fault indicators.

6.3. Substation Inspection

Substation Operations shall be notified to check affected substations and obtain relay target information per substation procedure SMP 400.87.2 – Emergency Response Before Re-Energization. It is also important that all substation data be obtained from other owner's facilities for joint ownership lines.

It should be noted that it is important to inspect substations for damage as soon as possible after a Circuit Interruption, even for an event that does not appear to directly involve substation equipment. Situations to look for should include:

- Substation equipment falling within the zone of protection of a line. Equipment includes surge arrestors, potential devices and transformers.
- Additional substation damage resulting from fault clearing.

All equipment associated with the Circuit Interruption should be checked and deficiencies noted. This includes, but is not limited to circuit breakers, disconnect

switches, conductor, insulators and structures. Substation procedures and work practices for checking a station after a fault should apply here.

All control system equipment associated with the interruption should be checked for signs of failure. This includes inoperable red lights, smoke, burned wires, burned relays and malfunctioning batteries.

All indications/targets associated with the interruption should be noted. This includes alarms, mechanical relay targets, zone targets, breaker operation counter data and DTF data.

All pertinent information should be communicated to TCC to be documented in IDS per Attachment B.

6.4. Determining the Need for and Type of Patrol

Need for a Patrol - Final determination of the need for a line Patrol is the joint responsibility of TCC and In House Construction. The following should be considered when determining the need for a Patrol:

- Faults, whether they occur on line, station or other equipment, typically subject all adjacent equipment to a large amount of fault current. This can cause additional problems on the line such as failed connectors. This should be considered when making the decision to either omit or shorten a Patrol. In most cases, a Patrol of the line, from end to end, will be necessary.
- If the cause of the interruption is determined to be a Misoperation, it may be determined that a line Patrol is not necessary. This decision should be made only after sufficient evidence clearly supports the Misoperation as the sole cause, in conjunction with Protection Standards and Support.
- All Interruptions where the cause is not completely known or where there is uncertainty should warrant a complete Patrol. This includes Interruptions during weather events, including lightning.

Timing of the Patrol - If determined to be necessary, Patrols should be conducted only when it is safe to do so and completed as soon as possible using the following criteria:

CIRCUIT PATROL CRITERIA		
CIRCUIT CLASS	MOMENTARY	SUSTAINED
Transmission	Initiate Patrols Within 5 Day	Initiate Patrols Immediately
	Complete Patrols Within 7 Days	Complete Patrols ASAP
	Patrol of Entire Circuit is Strongly Suggested	Patrol of Entire Circuit is Mandatory
	Check Stations Within 24 Hours	Check Stations ASAP

Note: TCC, In House Construction, Transmission Line O&M Engineering and/or T&D Performance Reporting evaluations (possibly others) may determine that a Patrol needs to be expedited based on recent circuit performance, system conditions or configuration, Load at Risk, or other critical factors, and should be carried out by In House Construction as requested.

Long term events such as hurricanes and ice storms may make the timeframes above impractical to follow. In such cases, the decision to follow an alternate set of timeframes is to be made by TCC, in conjunction with In House Construction.

If a circuit experiences additional Momentary Interruptions before a Patrol can be completed, the Patrol should be expedited if possible.

Type of Patrol - In House Construction has the ultimate authority to determine which type of Patrol can be safely performed and who can safely perform it. Aerial Patrols are preferred and should be undertaken wherever possible. In circumstances where an aerial Patrol cannot be executed, ground based Patrols shall be performed as required. If a ground based Patrol is performed, a follow-up aerial Patrol should be considered when possible.

Ground based Patrols may also be conducted to complement an aerial Patrol.

If the decision not to execute a Patrol is made, the reason shall be documented in IDS. It is possible that more than one Patrol may be needed based on outcome. If it is determined that a Patrol is necessary, this decision and the type of patrol shall be documented in IDS per Attachment B and the remaining steps in this procedure shall be followed

7.0 Procedure - Patrol

7.1. Initiating the Patrol

In House Construction shall be notified to initiate the Patrol within the decided timeframe.

In House Construction will designate a Field Patrol Lead prior to the Patrol and identify them to TCC. The Field Patrol Lead shall:

- Be responsible for the Patrol in the field
- Keep track of who is performing the Patrol
- Determine the most effective and efficient methods to perform the Patrol
- Determine who performs the Patrol
- Determine if and when the Patrol can be performed safely.
- Act as the conduit for all information communicated to and from the field.

Joint ownership circuits require special attention. No Patrols shall be performed on other owner's facilities without proper notification and approval. TCC shall have this discussion with the other owner(s) and then make the Field Patrol Lead aware of the arrangements.

7.2. Performing the Patrol (General)

All applicable safety and environmental rules must be followed when executing the Patrol. All elements of the Patrol shall be executed by personnel qualified to perform the task. All Patrollers are responsible to maintain communication between themselves and the Field Patrol Lead at all times and report any pertinent information when found.

Anyone joining the Patrol shall make themselves known to the Field Patrol Lead.

The Field Patrol Lead shall communicate all information to TCC as soon as possible. This would include areas not patrolled, location(s) of findings and repairs. This data shall be documented by TCC in IDS per Attachment B.

Discovered problems should be noted and compared against known problems to determine if there are any anomalies that may help narrow down the search for the cause. All could indicate an abnormal problem which could be at or several sections away from the one observed. Items to look for include:

- Insulators out of plumb
- Abnormal sag of one or more conductors or shield wires
- Structure abnormalities
- Flashed or damaged insulators
- Downed or leaning trees/branches
- Conductor damage
- Burned poles/cross arms
- Areas of burned ROW which could indicate a lightning strike location,

- Broken or damaged poles/towers

7.3. Patrol Area

It is important to note that the purpose of the Patrol is to find all problems that contributed to, or resulted from, the fault(s) that caused the interruption. Therefore, it is important to perform a thorough Patrol if a line fault is suspected. In most cases, this will result in the line being patrolled from end to end (including taps). This guideline may not be practical due to conditions or the length of the line, but should be followed if possible.

Sustained Interruptions – All circuits shall be patrolled from end to end. The primary goal during any sustained outage is to safely Patrol the circuit by whatever means are available so as to be able to react, repair, and restore the circuit as soon as reasonably possible.

If little or no relay data is available, patrol circuit starting at one end. Otherwise, patrol circuit using relay/FALLS guidance located in Attachment A.

If an area of a circuit cannot be patrolled due to access issues, it should be reported to TCC. In this case an alternate form of patrol should be considered.

7.4. Performing the Patrol (Aerial - Preferred)

The circuit shall be patrolled according to the Aerial Visual Inspection Procedure PR.06.01.601.002.

All applicable notification rules will be followed including:

- REMVEC Operating Procedure OP 98
- New York Control Center Policies and Procedures 12.4 – Helicopter Patrol Notifications
- MDC (NE), Nuclear Stations, Other Foreign-Owned Facilities etc.

Aerial Patrollers shall be:

- Familiar with the circuits and geography being patrolled
- Trained for routine and emergency communications/procedures.
- Familiar with Patrol techniques and defect/cause identification as well as all applicable aerial Patrol/inspection safety procedures.

The pilot will determine the lowest altitude and speed that a Patrol can be safely performed. All procedures associated with helicopter flights shall be followed.

New technologies such as Gyro-stabilized binoculars, digital cameras, etc. are recommended tools that can be used to aid in viewing and recording defect data.

Equipment information on the line being patrolled such as GIS data and GPS coordinates should be obtained by the Patroller prior to the Patrol. In addition, a road crossing book can be used as an aid if available.

While not required, it may be beneficial to perform the Patrol flying in both directions to thoroughly search for all problems.

Patrols of jointly owned lines require TCC to notify the neighboring utility owner and share available information regarding the flight.

When a request to patrol foreign sections of Jointly owned lines is requested of National Grid by the neighboring utility owner, both control centers will come to an agreement regarding the patrol (i.e. sections to be patrolled, timeframe, etc.). This information will be logged and relayed to the patrol lead and pilot/observer (see 7.1).

7.5. Performing the Patrol (Ground Based - Alternate)

The circuit shall be patrolled according to the Ground Based Visual Inspection Procedure PR.06.01.601.001

Patrollers should visit as many structures as possible, with those structures that have no or limited access being viewed through binoculars.

When weather conditions, nightfall, or ROW access limit the extent of a ground based Patrol, the minimum Patrol shall include all road crossings and good access points, and as far as can be seen from these locations. Areas not patrolled shall be noted to TCC.

The minimum number of Patrollers performing ground based Patrols in a right of way shall be determined by the Field Patrol Lead.

7.6. Re-energization

Any attempts to re-energize the circuit after field personnel have initiated a patrol will be made only after the Field Patrol Lead is satisfied that all personnel including Helicopter patrol crews are clear of the circuit and in a safe area. Only after the Field Patrol Lead has given permission to do so shall a reenergization attempt be made by TCC.

Any re-energization activities shall follow current reclosing/re-energization guidelines.

If available, it is recommended to broadcast a message via radio that a circuit is being reenergized. This would be initiated by TCC.

Once a circuit is successfully energized, balanced, three phase load should be verified if possible. Unbalanced load could indicate an open circuit.

7.7. Analysis

Once the patrol is complete, applicable departments shall document all additional pertinent data in IDS per Attachment B including:

- Results of patrol (if undertaken)
- Cause (if determined)

This procedure is part of the Transmission Performance Trend Identification and Response Procedure – TOP17. Per this procedure, specific interruption or failure trends may be identified for further investigation with the results documented in IDS.

In cases where evidence of a Fault is not found during a Patrol and the official cause is classified as “unknown”, further analysis should be considered. This analysis may be initiated by T&D Performance Reporting using the TOP-17.

8.0 Attachment A – Relay/FALLS Interpretation Guide

8.1. General

Relay accuracy, especially zone and DTF data, as well as FALLS data can vary depending on system configuration and conditions. Because of this, this information should be treated as a guide and not an absolute. If there is any question as to the information that a relay provides, Protection Standards and Support should be consulted.

Zone and DTF data on circuits with more than two terminals tends to be less accurate.

8.2. Basic Relay Data

Basic relay data typically consists of no more than an identifier of which phase(s) the Fault was on. The Fault could be on the entire length of the circuit.

Instantaneous targets typically indicate Faults close to that terminal.

8.3. Zone Relay Data

Zone relay data looks for Faults in specific areas of the circuit (and beyond). This can very roughly assist in Fault location:

- Zone 1 – Looks out on the first 80% of the circuit, the Fault is likely there.
- Zone 2 – Looks out on 100% of the circuit and 20% beyond. With no other targets, the Fault is likely at the opposite end of the circuit.
- Zone 3 – Looks out on 100% of the circuit and 100% beyond. This relay is timed for breaker failure and usually indicates a problem on an adjacent circuit with a slow or stuck breaker.

Single Terminal Zone Data:

- Zone 1 – Patrol starting at the terminal and focus on the first 80% of the circuit.
- Zone 2 – If only a Zone 2 target is obtained, patrol starting at the opposite end of the circuit and focus on the first 20%.
- Zone 3 – Likely a fault on an adjacent circuit with a slow or stuck breaker.

Multiple Terminal Zone Data (Terminal A, B...):

- Zone 1 – If multiple terminals have Zone 1 targets, patrol starting at the overlap(s) of the first 80% of the circuit length out from each terminal (i.e. the middle 60% of the circuit).
- Zone 2 – If multiple Zone 2 targets are obtained, patrol entire circuit as if no zone targets exist.
- Combinations – If Terminal A has a Zone 1 target and Terminal B has a Zone 2 target, patrol starting at the first 20% of the circuit length out of Terminal A. For

other combinations of Zone 1 and Zone 2 targets, focus first on the overlap of the zone areas using the above guidance.

- Zone 3 – Likely a fault on an adjacent circuit with a slow or stuck breaker.

In communication assisted schemes involving POTT, the Zone 2 elements at each terminal operate high speed giving you Zone 2 targets at both ends. Fault can be anywhere on line. Zone 1 may also operate at one end or both which may help in narrowing down the search. To determine the area to focus first on, overlap of the zone areas using the above guidance.

8.4. DTF Relay Data

Distance to Fault (DTF) Data - Can be obtained from selected relays located at the circuit terminals. After a Fault, these relays have the ability to roughly calculate the distance to the Fault from the relay. TCC Rooms shall be furnished with locations of DTF relays.

Some DTF relays communicate data directly to the control room via EMS.

If not available through relays, DTF data is sometimes available via Digital Fault Recorders, if installed. This data can be obtained through Protection Standards and Support during normal business hours or via Protection and Telecommunication Operations after hours.

Accuracy of DTF data can vary depending on Fault condition and system configuration. It usually can be counted on to be no more accurate than 1.5 miles.

To obtain better DTF accuracy, it may be advisable in some cases to have Protection Standards and Support analyze and revise the DTF data. This may be helpful, especially where a circuit has had previous “unknown” interruptions.

If DTF information is available:

- Single DTF Relay - Initially patrol 1.5 miles on each side of the calculated Fault location, then patrol the rest of the line as necessary.
- Multiple DTF Relays – Initially patrol 1.5 miles on each side of the area bordered by the multiple Fault locations, including the area, then patrol the rest of the line as necessary.

8.5. Relay Summary

Basic Relays	Initial Patrol Area
No Relay Data	Entire circuit
Basic Relay Data Only	Entire circuit, focus on phase
Instantaneous Relay	Entire circuit, starting at terminal w/instantaneous relay
Zone Relays	Initial Patrol Area
Single Zone 1	80% of circuit out from Zone 1 terminal
Single Zone 2	20% of circuit opposite Zone 2 terminal
Multiple Zone 1	Middle 60% of circuit
Multiple Zone 2	Entire circuit
Multiple Zone 1 and Zone 2 Combinations	20% of circuit out from Zone 1 terminals
Zone 3	Fault is likely on an adjacent circuit
DTF Relays	Initial Patrol Area
Single DTF terminal	1.5 miles on each side of the DTF location
Multiple DTF Terminals	1.5 miles on each side of the area bordered by the DTF locations, including the area between the locations
Note: This table identifies <u>initial patrol areas</u> to focus on where the probability of finding the fault is higher. In most cases, a subsequent patrol of the <u>entire line</u> should be executed.	

8.6. Falls Analysis

FALLS lightning data is available to TCC and can pinpoint the approximate location of lightning strikes. This can be useful in finding a Fault caused by lightning. This data should be made available to the Field Patrol Lead and should include the estimated location of the strike (via coordinates, address, distance from station etc.).

It should be noted that the data from FALLS lightning analysis is approximate and should be treated as such. It is possible that the location calculated by FALLS may differ from the actual by up to several miles.

9.0 Attachment B – IDS Documentation Requirements

9.1. Initial IDS Documentation Requirements

Documentation should follow IDS entry guidelines but should include the following information to assist in patrols and potential investigations. This information shall be communicated to the Patrol Lead by TCC prior to the patrol commencing.

Documentation	Field	By
Line Name and Terminal Information	Specified	Transmission Control Center
Time/Date of Interruption	Specified	Transmission Control Center
Known Details at the Time of Interruption	Comments	Transmission Control Center
Weather Data	Specified	Transmission Control Center
FALLS Data (estimated location of strike)	Comments	Transmission Control Center
Pre-Fault Loading Data (if available)	Comments	Transmission Control Center
Target Data – DTF from EMS (specify distance & when obtained)	Specified/Comments	Transmission Control Center
Cause (if known)	Specified/Comments	Transmission Control Center
Fault Indicator Information	Comments	Transmission Control Center

Documentation (after station inspection)	Field	By
Target Data – DTF (specify distance)	Specified/Comments	Transmission Control Center
Target Data – Zone (specify zone)	Specified	Transmission Control Center
Target Data – Mechanical	Specified	Transmission Control Center
Station Info/Alarms (if pertinent)	Comments	Transmission Control Center

Documentation (after patrol is complete)	Field	By
Patrol Date/Type of Patrol/Patrol Not Executed-why	Comments	T&D Performance Reporting
Proper/Improper Operation	Specified	T&D Performance Reporting
Results of Patrol	Comments	T&D Performance Reporting
Cause (if known)	Specified/Comments	T&D Performance Reporting

