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QUALITY AND INNOVATION IN TRANSMISSION AND DISTRIBUTION SINCE 1947

ERS

Emergency  
Restoration  
System  
**600H-Series**

# 600H-Series Emergency Restoration System Structures

## Strong, dependable modular transmission structures for transmission line emergencies, line maintenance, and construction needs

Lindsey 600H-Series Emergency Restoration System (ERS) structures are designed for maximum design flexibility and speed of installation while bypassing damaged transmission towers, performing line maintenance, and in moving or supporting lines during construction projects. Key features include:

- Almost 2x the buckling load capacity compared to narrower profile structures.
- All components weigh less than 100kg, simplifying transport by hand to remote or hard to access.
- Line Crew Safety features including flat climbing surfaces, compatibility with all commercially available fall arrest systems, and four-man single level access.
- Welded aluminum construction eliminates concern of corrosion regardless of environment or repeated use.
- Compatible with hand, crane, and helicopter installation methods.
- Store and transport in standard 20-foot containers.

### The Need for ERS Structures



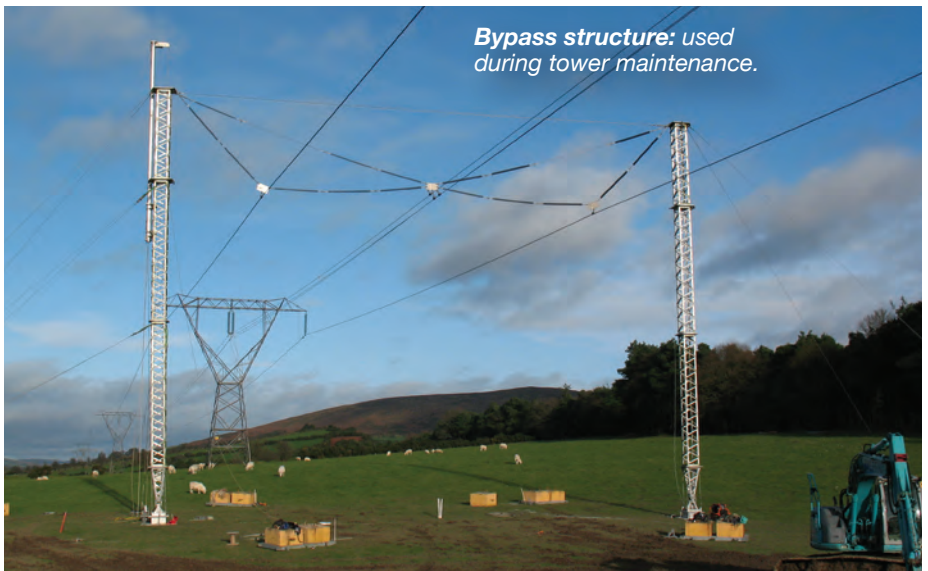
*400kV tower failure due to a hurricane resulting mud slide.*



*500kV tower toppled by dynamite. Lindsey ERS (far left) used for bypass*



*115kV steel monopole failure resulting from high winds and debris.*



***Bypass structure:** used during tower maintenance.*

**EMERGENCIES:** Whether caused by exceptional acts of nature or uncontrollable acts of mankind, transmission lines are vulnerable to mechanical failure. The resulting loss of transmission is expensive. In addition to the cost of repairing or replacing damaged towers, monetary costs may also include the supply of power from less economic resources. Further, the political costs of an extended power outage may be incalculable. ERS structures enable rapid re-energization of a line while damaged towers and footings are repaired or replaced.

**CONSTRUCTION:** Normal line maintenance and other construction projects often involve relocating line spans, bypassing existing towers or substations, or building temporary jumpers. ERS structures can make such projects more efficient by reducing the time needed for such lines relocations. Being reusable, ERS structures can reduce the cost of use-once poles and structures.

# The Lindsey ERS Heritage

Lindsey ERS structures have been the leading choice of utilities for decades to provide for unscheduled transmission tower restoration and scheduled construction at any voltage in any terrain. Though designed for temporary use, the robustness of their design is the reason why many utilities have left Lindsey ERS towers in continuous service for over two decades and counting.

The key indicators of performance for ERS structures, as for any guyed tower, are its buckling strength and the strength of tower attachment points. As a result all Lindsey ERS series have:

- Superior buckling capacity for better performance of tall structures under high loads
- At least twice the strength-to-weight ratio of other towers.
- Three times stronger insulator and guy wire attachment points for maximum safety of other towers.

ERS Series	1070	600L	600H	800	Non-Lindsey
<b>Standards Compliances</b>					
Design and Testing Compliant to IEEE Std. 1070 and IEC-60652	Yes	Yes	Yes	Yes	Varies
Dimensionally Compliant to IEEE Std. 1070	Yes	No	No	No	No
Column Width (mm)	610	575	575	750	412 - 478
<b>Performance</b>					
Relative buckling strength	150%	100%	130%	300%	75%
All extruded or plate aluminum construction	Yes	Yes	Yes	Yes	Varies
<b>Installation</b>					
All system components, weigh <100kgs	No	Yes	Yes	No	No
Manual, crane or helicopter installation	Yes	Yes	Yes	Yes	Yes
<b>Safety</b>					
Accepts all commercially available fall arrests systems	Yes	Yes	Yes	Yes	No
Flat climbing surfaces	Yes	Yes	Yes	Yes	No
Maximum number of workmen at one level	4	4	4	4	2
<b>Packaging</b>					
Column sections pack into 20' containers	No	Yes	Yes	Yes	Yes
Other system components pack into 20' containers	Yes	Yes	Yes	Yes	Yes

## 600H-Series

### Reliability and Safety

The Lindsey Series 600H ERS System is a fully integrated solution based on decades of experience in supplying emergency restoration systems consisting of: The Lindsey 600H ERS system is designed and manufactured to the highest standards.

- Design and proof tested to IEEE Standard 1070-206, the only world-wide accepted standard for ERS.
- Testing performed in accordance with IEC-60652.
- Loading Tests on Overhead Line Structures.
- Lindsey is ISO-9001 Compliant Certified for Design and Manufacture of ERS.

### Experience

Lindsey has supplied thousands of ERS structures to transmission asset owners, contractors, and military organizations around the world. Lindsey has a 70-years history in meeting the needs of transmission operators.





## ERS Structures at Work Emergencies



### **Foundation failure of a double circuit tower:**

One 3-phase horizontal-vee ERS structure has been erected and is supporting one circuit. A second ERS was then installed on the other side of the tower to support the other circuit. This type of double bypass allows for both circuits to be restored, allowing the permanent tower to be rebuilt while both circuits are energized. Once the replacement foundation and tower are in place, the circuits can be easily moved back to the permanent tower one at a time while keeping one circuit energized.



### **Tower collapse due to sabotage:**

A three phase chainette structure is built straddling the remains of the destroyed tower. This allows for minimum diversion from the existing right-of-way. This also provides room for rebuilding a new tower in place.

This structure was built, and the line returned to service in just 8 hours after the material arrived at site.

Where standard tower design carries the 3-phases in a horizontal arrangement, the chainette structure simplifies lifting of the phase conductors.



# ERS Structures at Work

## Construction

600H-Series

### **Tower Replacement:**

A Lindsey ERS structures is seen in the background being prepared to offload the conductors from one circuit of a transmission tower. In the foreground is the base of a new, larger, tower that will be replacing the double-circuit three phase tower on the left. Lindsey ERS structures are widely used during line and substation construction projects. The ability to quickly and temporarily relocate conductors and line segments provides great flexibility during project work. Lindsey ERS structures allows for adapting to almost any situation and are widely used by utilities and contractors alike.



### **Reconductoring:**

A string of restoration structures can be seen adjacent to the transmission line. The phase conductors of one circuit of the double circuit tower were moved to the ERS structures. The line was then reenergized allowing for new conductors to be strung on the permanent towers. Here, the reconductoring is completed and the ERS structures will be moved to the other side of the towers for reconductoring of the second circuit.



## Elements of an Effective Emergency Restoration System

An effective ERS system consists of three core elements:

- Modular structures
- Analysis tools and advanced planning
- Field training

### Modular Structures

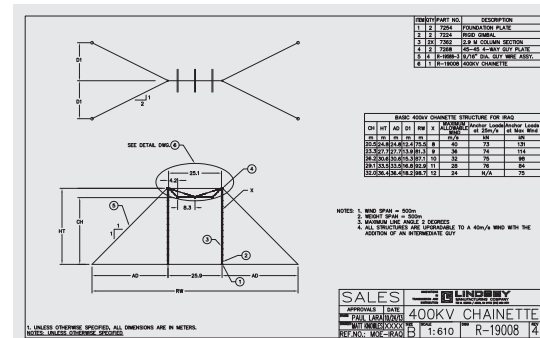
Two of the most difficult requirements for restoration of a damaged transmission line are construction of a new foundation and replacement of damaged tower steel. Tower steel is often stocked; however, predicting the requirements for every possible failure and stocking all the necessary material is difficult and uneconomical. Similarly, construction projects may require a wide range of tower configurations that are difficult to foresee.



Lindsey series-600H structures are a more effective and economic solution. They provide system of modular components that can be arranged in virtually unlimited configurations to meet restoration and construction needs. Key features include:

- Lightweight welded aluminum construction for ease of transport, rapid installation, long-term
- Storage, and durability.
- No special foundation requirements.
- Usable at any voltage level, AC or DC.
- Suitable for suspension, angle, or tension.

### Analysis Tools and Advanced Planning



A pre-designated Basic Chainette for 400kV allows field crews to build a quick structure without waiting for additional engineering.

All Lindsey ERS systems includes ProSpot® software, an ERS design and analysis package that can be used to plan the design and placement of the Lindsey ERS structures. It is designed for ease of use, requires minimal input, and clear output for field personnel.

The asset owner's engineering staff should pre-design those restoration structures most likely expected to be used and be trained to quickly analyze any special emergency situation that occurs.

### Field Training

Efficient use of ERS structures requires properly trained and experienced field personnel. Lindsey offers training services in the assembly and erection of the series-600H-series structures. Training covers various erection techniques using a variety of equipment.

Lindsey works closely with the asset owner, drawing on over three decades of experience in emergency restoration, to develop techniques that are appropriate for each utility's unique situation.





# ERS System Structural Components

600H-Series

## Column Sections

All column sections are fabricated from lightweight, high strength structural aluminum alloy. The all-welded construction insures easy handling and eliminates the loss of small bolted pieces.

Column sections are available in 2.90m and 1.45m sections, weighing 95kg and 59kg, respectively. Four high strength M24x3x210 galvanized bolts hold each column section to the next.

Columns are easy to climb and allow up to four linemen to stand at one elevation. Each column section is inspected to insure straightness and reliability.

## Foundations and Gimbal Joints

The Foundation (Part Number 7254 weighing 60kg) is made from 1.2m by 1.2m aluminum plate and is designed to be placed directly on the ground to provide bearing support. The design of the Lindsey Foundation allows for several rigging attachment points used for erection of the columns or for raising the conductors.

The Gimbal or articulating joint (Part no. 7224).

## Guy Plates

High Strength Guy Plates are made from structural aluminum plate and directly transfer the insulator loads across the structure and into guy wire loads. Each attachment hole is designed to hold a 134kN load. The Guy Plates are attached to the four (4) holes between or on the top of each column section using high strength M24x3x210 galvanized bolts.

## Post Insulator Supports and Hanger Straps

The post insulator support (Part No. 7267, weighing 10kg) is designed to attach at the joints between column sections. The design of the post insulator support provides a universal pivot point for the post insulator, eliminating bending moments on the post insulator and thus increasing the insulator's buckling strength.

*Hanger Straps (35kg) – (shown to the left and above the upper lineman) These hold the suspension insulator in a horizontal-vee assembly and provide a restoring moment for the assembly under longitudinal loads.*



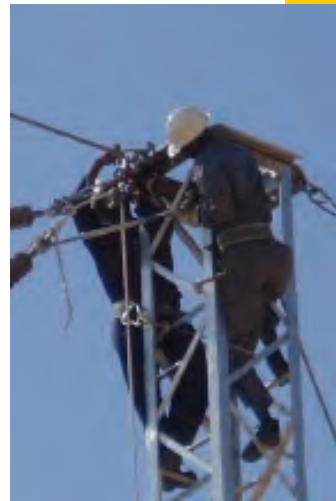
Part No. 7262 is 2.9m long and weighs 95kg.



Part No. 7263 is 1.45m long.



Part No. 7288 45 degree 4-way Guy Plate, (shown above), can be located at the top of columns or placed between column sections.



The Gimbal or articulating joint (Part no. 7224 weighing 77kg) acts as a universal joint eliminating torsion loading of the final structure and allowing the assembled column to be rotated from the horizontal plane to the vertical position from any position.





## 600H-Series

## Series 600H ERS Accessories

### Insulators and Hardware

A minimum number of different types of hardware are to be provided in order to minimize confusion during emergencies. For example, only one size of anchor shackle is provided. All hardware will have ultimate load ratings to withstand the maximum structure loading. All ferrous materials are galvanized. Routine mechanical pull tests are to be applied to all hardware items in accordance with IEEE Std 135.61-1997.



*Lindsey guarantees the assembly and fit of all hardware assemblies.*



Light weight, non-ceramic insulators are supplied with Lindsey ERS structures. These insulators conform to all applicable electrical and mechanical tests as required by both ANSI and IEC standards. Insulators meeting utility specific special requirements are also available.

### Anchors

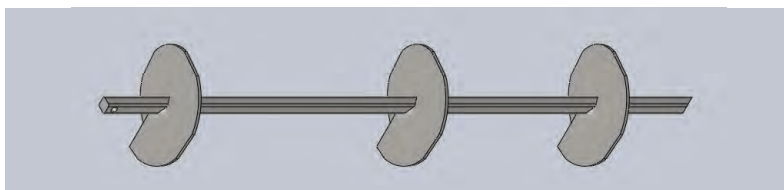


*Installing and final locking of the normal soil density hydraulically installed self locking anchor.*



#### *Anchor installation kit*

Cross plate anchors are a very common and universal anchoring method, requiring minimal installation equipment. In normal soils each cross plate anchor will require approximately 4 hours to install by hand.



Anchoring is a critical element of any guyed Lindsey Emergency Restoration System. Depending on the prevailing soil conditions, a number of different anchoring arrangements can be provided. In general, Lindsey does not recommend temporary anchors for construction, but only the use of the permanent anchors

during construction of the structures. For normal soil conditions, hydraulically installed self locking type anchors can be installed in 15-20 minutes. The advantage of these type anchors, besides their speed of installation in normal soils, is that they are proof tested during installation. Anchor installation kits are supplied with these types of anchors.

*For normal or low-density soil conditions, i.e. swamp or peat, high strength triple helix screw anchors can be provided.*

*Rock anchors and dead weight anchoring systems can also be supplied to meet specific requirements.*



# Series 600H ERS Accessories

600H-Series

## Construction Tools

All necessary construction tools and hand tools can be provided for assembly, erection and lifting of the conductors of a complete emergency restoration structure.

- 7271 Gin Pole (optional) is designed to support manual installation of ERS. Made from aluminum alloy, the gin pole is supported on one corner of a column section and allows for the lifting of column sections to the top of the structure.
  - All necessary snatch blocks and rigging ropes are included.
  - The gin pole davit arm keeps loads clear of the structure while being raised by manpower, or a capstan with hydraulic power unit.
- 7004 Hydraulic Capstan (optional) is a 1-ton hydraulic capstan winch with foot pedals. This capstan is capable of being powered by the same hydraulic power unit used to install anchors.
- 7060 Double Roller Clamps (optional) combine the function of a double stringing roller and a conductor clamp, simplifying conductor installation.



The Lindsey **7271** Gin Pole.



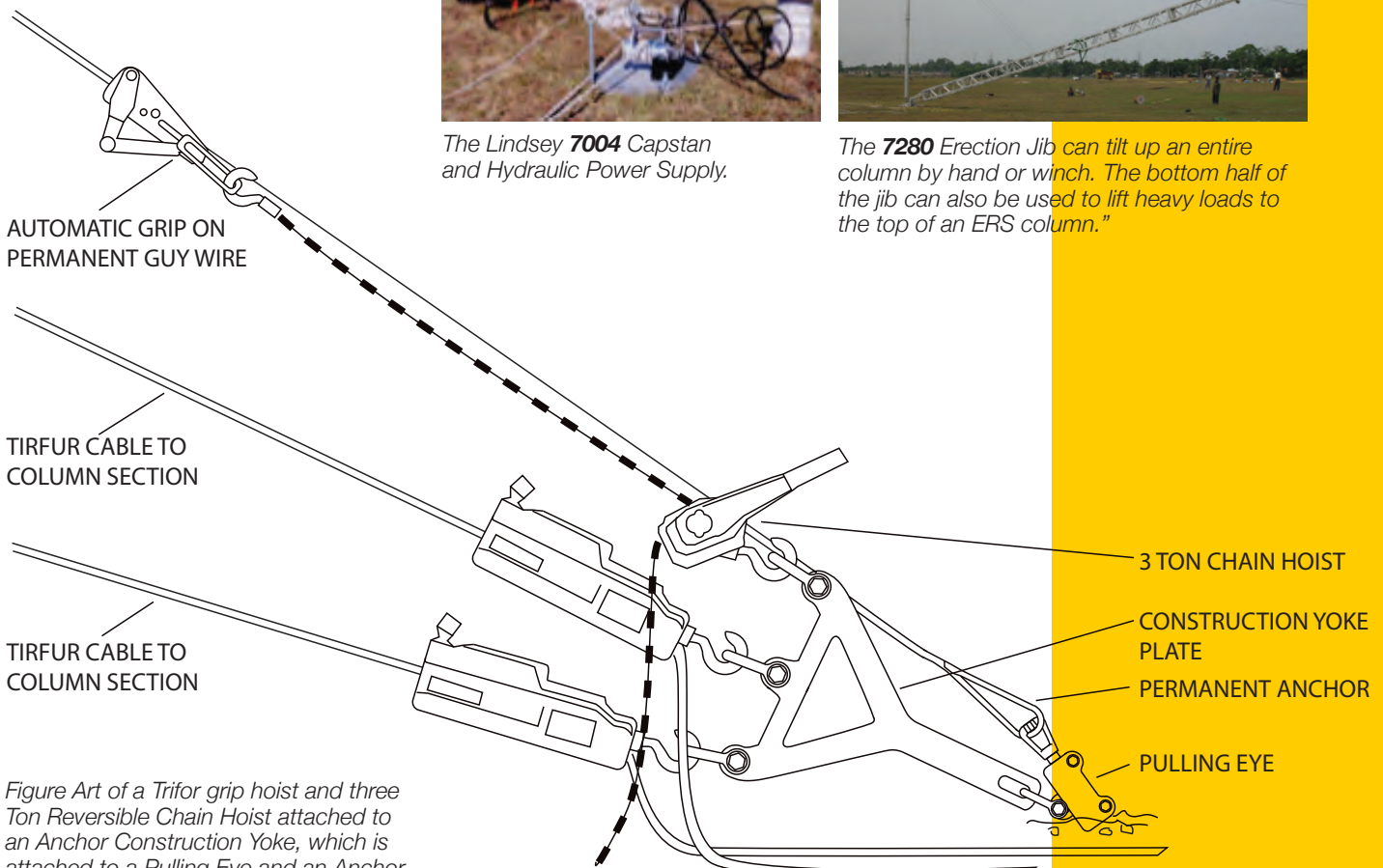
**7060** Double Roller Clamps simplify stringing.



The Lindsey **7004** Capstan and Hydraulic Power Supply.



The **7280** Erection Jib can tilt up an entire column by hand or winch. The bottom half of the jib can also be used to lift heavy loads to the top of an ERS column."



## 600H-Series



## Storage and Transportation

### Storage

ERS systems are intended for rapid deployment in times of emergency. Lindsey 600H-Series ERS systems are shipped in standard 20 foot ocean cargo storage containers, ensuring all ERS system components are kept together and readily transportable to site.

- Standard containers contain ERS tower components, associated insulators and hardware, anchors and guy wire.
- Specially fitted tool containers are provided when optional construction tools are ordered.
- Custom container designs to meet special requirements are available.

ERS system structural components can also be store outdoors as they are made from corrosion resistant, high-strength, 6061-T6 aluminum alloy. Unlike galvanized structures, these can be stored outside indefinitely, even in marine environments.

### Field Transport

The lightweight modules that make up Lindsey ERS system structures provide great flexibility in moving the system to the job site. Containers can be moved by truck. Unpackaged material can be moved by small, all vehicles trucks, or by hand. Individual components, and partially or fully assembled structure columns can be transported by helicopter.

*Containers can be transported near the job site and unloaded. From there, the ERS Structures can be taken to the construction site by hand, small truck or helicopter.*





## 600H-Series

## Construction Methods and Safety

### Construction Methods

Lindsey ERS system structures are compatible with a wide variety of construction methods, including:

- Manpower only utilizing a Gin Pole
- Winch Line and Erection Jib
- Small or large cranes
- Helicopter

This flexibility allows for rapid structure erection in any terrain or environment.

### Safety

The enhanced safety features of the 600H-series Lindsey ERS make all tower climbing activities secure, safe, and comfortable for field personnel.

- Full compatibility with all commercially available fall arrest systems ensure personnel are using equipment and methods in which they are familiar.
- Flat climbing surfaces on all sides provide for comfortable, fatigue free, secure footing. This eliminates the need to carry detachable steps.
- Man-width tower design provides for up to four workmen to stand comfortably at the same level. Unlike narrow tower designs where a workman must straddle the tower corners, this allows multiple workmen to assist each other.



*Photo taken during a training session, showing how four linemen can work at the same level of the Lindsey ERS structure.*



#### **Helicopter:**

The lightweight of the 600H series ERS makes it ideal for helicopter construction. Helicopters can either help to right columns built on the ground, or carry them to site.



*Above, **Winch Line and Erection Jib:** ERS columns can be tilted up with a winch line and the optional Erection Jib.*

*Left, **Manpower and Gin Pole:** 230kV tension structure built only by manpower in the Himalayas. The ERS structure spanned 710m to the structure circled in red.*



***Cranes:** Cranes allow for assembly on the ground and rapid ERS installation.*



## Training and Technical Support

### Training

Training sessions for personnel not familiar with an ERS system is crucial. Lindsey offers both on-site and off-site training services for both comprehensive training and refresher courses. All training is conducted by experienced application engineers.

### Classroom Training

Classroom training can be on-site or off-site. It is customized to fit your organization's requirements and can include:

- Emergency Restoration System fundamentals
- Restoration scenario analysis
- ProSpot® ERS Design software training for engineering staff

### Field Training

Field training is usually conducted on the ERS owner's site, though it may also be conducted at a third party location. Use of the asset owners equipment ensures linemen can focus on the ERS system, not new equipment. Field training may include:

- Actual field construction of a variety of ERS structures
- Training and practice using several construction techniques including crane and helicopter techniques if desired.

### Technical Support Services

Besides training, Lindsey offers a variety of technical support services, including:

**Order Support:** Lindsey can assist your operations and engineering personnel to determine the most efficient and economic ERS system to meeting the unique needs of your system or application. A form detailing information needed to preparing a budgetary quotation is available at: [www.lindsey-usa.com/ers-form](http://www.lindsey-usa.com/ers-form)

**Inventory Review:** Whether an ERS has been in storage for ten years, or was used last week, a periodic inventory review is a best practice. It may be necessary to replenish consumables like anchors, replace worn items such as guy grips, or replace any items that may have been unintentionally damaged or have gone missing. Lindsey can send an ERS engineer to help perform a proper inventory.

**Restoration Scenario Support:** Lindsey engineers can assist in analyzing various transmission tower failure situations and developing appropriate restoration scenarios.









**Full Tension:** These full-tension dead-end structures were built to support the line while a permanent tower was being replaced.



**Running Angle:** 400kV single phase running angle towers.



**Delta:** Part of bypass around 220kV collapsed towers.



**Three-phase single column Tension:** Supporting 3-bundle conductors.



**Four Column:** 400kV ERS built in one day to support a line from a nuclear power plant.



## Examples of Structures

600H-Series



**Tension (Dead-End):** Full tension dead-end of 400kV 4-conductor bundle.



**Running Angle:** 400kV double bundle conductor built in marsh.



**Herringbone:** 400kV Herringbone suspension structure supporting 1200 meter span.

**Horizontal Vee:** Multiple 220kV ERS structures used during tower replacement.



**Chainette:** Three-phase 150kV suspension structure built to support line while replacement tower was built underneath.



# More Solutions to Enhance Transmission System Operations

## **SMARTLINE®-TCF Transmission Capacity Forecasting System**

SMARTLINE-TCF informs a transmission line's actual power handling capacity based on forecast weather conditions.



Numerous studies show that most transmission lines can carry 10-25% more power or more 95% of the time. Knowing this capacity exists in advance provides greater flexibility in operating the grid. SMARTLINE-TCF is a high accuracy line capacity forecasting system for use by your EMS operators. Capacity forecasts are available in any increment from 1- to 48-hours with 99% or better accuracy. These ratings are suitable for use by operations and economic dispatch personnel.

## **TLSM™ Transmission Tower Security Monitor**

The Lindsey TLSM security monitor provides early warning of tower steel theft and attempts to compromise tower integrity.



Theft of steel members weakens transmission towers making them susceptible to collapse under otherwise normal environmental conditions. The result are power outages and time-consuming, expensive repairs. The TLSM security monitor detects human presence at the tower base while identifying vibration patterns associated with tower tampering. Suitable for use on most structures, the TLSM security monitor is an effective, easily installed, self-powered transmission tower intrusion monitoring solution for system voltages up to 765kV.

## **TLM™ Conductor Monitor**

Real-time, conductor clearance measurement device for facility ratings, compliance and dynamic line rating applications.



The Lindsey TLM® Conductor Monitor provides a complete picture of conductor behavior including actual conductor clearance-to-ground, conductor temperature, line current, and vibration. Unlike other transmission line monitors that use ancillary measurements to infer sag, not clearance, the TLM monitor provides accurate, actionable, clearance-to-ground distance measurements. The TLM monitor may be used at system voltages up to 765kV.



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