Introduction of Innovative Conductor

June, 2018 @ ACEF

TOKYO ROPE INTERNATIONAL INC.

CFCC ACFR Division
Company Profile

- Established: 1887
- Number of Employees: 1,800
- Sales: US$ 650 million
- Products:
  - Steel Wire Rope, Synthetic Fiber Rope, Carbon Fiber Cable,
  - Steel Cable for bridges
  - Steel Cord for tire reinforcement, Sawing Wire
  - Engineered Products for road safety devices, environment protection
  - Steel Wire Products for industrial and machinery applications
  - Die, Tool for wire products and forging
TOKYO ROPE’S STRENGTH

Stranding Specialist

Globally the first company to strand the carbon composite material
Overhead Conductor Market

**Current**

Conventional type conductor cable: **ACSR**

Awaiting Solutions:
- Heavy steel core
- Large thermal expansion
- Corrosion

**Challenge**

Marketing needs...
- Huge Electric Demand
- Environmental Concern (CO₂)
- Sag Violations
- Right of Way issue
- Construction cost & period

**Solution**

Next generation conductor cable: **ACSR**

- Low transmission loss
- High transmission capacity
- Low sag
- Longevity
- Easy handling
Transmission Capacity Increasing Method

1, Ampacity Based Solution

- Conductor Based Method
  - Conductor Change
    - Bigger Size
    - Increase number of Conductor
    - HTLS Solution
      - (High Temperature Low Sag)
  - New Line

- Operation Based Method

2, Voltage Based Solution
Carbon Fiber Conductor is the best option for low loss.
What is ACFR.

<Conventional overhead conductor cable: ACSR >

“Aluminum Conductor Steel Reinforced”

- Steel wire core → Heavy weight / Large thermal expansion
- Round shaped aluminum wire → Small cross sectional area

VS.

<High performance conductor cable: > ACFR.

“Aluminum Conductor Fiber Reinforced”

- CFCC → Light weight / Small thermal expansion
- Trapezoidal aluminum wire → Large cross sectional area
Aluminum for ACFR

Application

Low Resistance

Better sag

Easy Installation and Handling like ACSR

Conductive Outer Layer

1350-0 temper

Market

Indonesia

China

Malaysia

Japan

Taiwan

Brazil

<table>
<thead>
<tr>
<th>Conductivity</th>
<th>Hard-drawn A1350-H19</th>
<th>Annealed A1350-O</th>
<th>Thermal-resistant TAI (AT1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>[%IACS]</td>
<td>61.2</td>
<td>63.0</td>
<td>60.0</td>
</tr>
<tr>
<td>[%]</td>
<td>100</td>
<td>103</td>
<td>98</td>
</tr>
<tr>
<td>Maximum operating temperature</td>
<td>90</td>
<td>250</td>
<td>150</td>
</tr>
</tbody>
</table>

| Tensile Strength [MPa] | 162-172 | 55-96 | 165-186 |

* See Annex 2-1 for examples of ACFR specification.
## Core Material – Different Technology

<table>
<thead>
<tr>
<th></th>
<th>ACSR</th>
<th>ACSS</th>
<th>STACR</th>
<th>Solid CCC</th>
<th>ACFR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strength</strong> (MPa)</td>
<td>1,300</td>
<td>1,381</td>
<td>1,275</td>
<td>2,158</td>
<td>2,158</td>
</tr>
<tr>
<td><strong>Modulus</strong> (GPa)</td>
<td>200</td>
<td>200</td>
<td>152</td>
<td>117</td>
<td>130</td>
</tr>
<tr>
<td><strong>CTE</strong> ($\times 10^{-6}/^\circ C$)</td>
<td>11.5</td>
<td>11.5</td>
<td>3.7</td>
<td>1.6</td>
<td>1.0</td>
</tr>
<tr>
<td><strong>Weight</strong> (kg/km)</td>
<td>1.3</td>
<td>1.3</td>
<td>1.3</td>
<td>1.1</td>
<td>0.9</td>
</tr>
</tbody>
</table>

**High Strength**

**Low expansion**

**Lesser Weight**
“Carbon Fiber Composite Cable”

Stranded CFRP developed by TOKYO ROPE

- **Light Weight**: 1/5 of Steel
- **Low Linear Expansion**: About 1/10 of Steel
- **High Strength**: 30–40% more than Steel for conductor core
- **Non-magnetic**: No Iron Loss
- **High Flexibility**: High bending angle, smaller diameter of stringing sheave
- **High Corrosion resistance**: Against acid, alkali, water and UV
- **High Tensile Fatigue**: Able to withstand wind vibration
- **Low Creep Elongation**: Similar to Steel
- **High Modulus**: Equal to Steel
Ingredient of “Torayca®”, Carbon fiber made by TORAY

Torayca® is applied to state of the art aircraft such as Boeing 787
~ History of CFCC and ACFR ~

1980s  Started development of **CFCC**
1986   Supplied for PC Bridge Project in Japan
2001   Supplied for PC Bridge project in Michigan/USA
2002   Supplied for **ACFR** project in Japan
2011   Estimated Gamagori **CFCC** Plant in Japan
        (First full-scale integrated **CFCC** factory)
2012   Supplied for **ACFR** project in China
2015   Supplied for **ACFR** project in Indonesia
2016   Estimated Michigan **CFCC** Plant in USA
        (First overseas **CFCC** production facility)
## Case Study 400 KV – CTU & STU

<table>
<thead>
<tr>
<th>Description</th>
<th>ACSR Moose</th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (kV)</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (122 Kg/sq.m)</td>
<td>6740</td>
<td>6740</td>
</tr>
<tr>
<td>Tension @ 5 deg. 36 % of Full wind (44 Kg/Sq.m)</td>
<td>4712</td>
<td>4712</td>
</tr>
<tr>
<td>Sag at 85 deg.c – 400 Span</td>
<td>13.26</td>
<td>13.26</td>
</tr>
<tr>
<td>Ampacity @ 85 deg.c</td>
<td>800</td>
<td>1500</td>
</tr>
</tbody>
</table>

Double Ampacity than the existing capacity
Without Violating the existing Ground Clearance
## Case Study 400 KV – Different Technology

<table>
<thead>
<tr>
<th>Description</th>
<th>ACSR Moose (mm)</th>
<th>Requirement</th>
<th>ACSS</th>
<th>STACIR</th>
<th>CCC</th>
<th>ACFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>31.77</td>
<td>≤ 31.77</td>
<td>30.19</td>
<td>28.95</td>
<td>31.77</td>
<td>31.77</td>
</tr>
<tr>
<td>Weight (Kg/Km)</td>
<td>2004</td>
<td>≤ 2004</td>
<td>1993</td>
<td>2001</td>
<td>1988</td>
<td>1968</td>
</tr>
<tr>
<td>Voltage (kV)</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
<td>400</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (122 Kg/sq.m)(Kg)</td>
<td>6740</td>
<td>6740</td>
<td>6648</td>
<td>6566</td>
<td>6569</td>
<td>6540</td>
</tr>
<tr>
<td>Tension @ 5 deg 36 % of Full wind (44 Kg/Sq.m)</td>
<td>4712</td>
<td>4712</td>
<td>4712</td>
<td>4712</td>
<td>4712</td>
<td>4712</td>
</tr>
<tr>
<td>Ampacity &amp; OT (Amps) &amp; (Deg.c)</td>
<td>800 (85)</td>
<td>1500</td>
<td>1500 (182)</td>
<td>1500 (175)</td>
<td>1500 (133)</td>
<td>1500 (131)</td>
</tr>
</tbody>
</table>

Lesser Sag and Low Operating Temperature than any other technology
## Case Study 220 KV – South India STU

<table>
<thead>
<tr>
<th>Description</th>
<th>Exiting ACSR Zebra Conductor</th>
<th>Need of STU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (Kv)</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Ampacity @ 75 deg.c</td>
<td>550</td>
<td>1200</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (83 Kg/sq.m)</td>
<td>4981</td>
<td>4981</td>
</tr>
<tr>
<td>Sag at 75 deg.c – 350 Span</td>
<td>9.24</td>
<td>9.24</td>
</tr>
</tbody>
</table>

More than Double Ampacity than the existing capacity Without Violating the existing Ground Clearance
Case Study 220 KV – Different Technology

<table>
<thead>
<tr>
<th>Description</th>
<th>ACSR Zebra</th>
<th>Requirement</th>
<th>STACIR</th>
<th>CCC</th>
<th>ACFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>28.62</td>
<td>≤ 28.62</td>
<td>25.5</td>
<td>28.14</td>
<td>28.62</td>
</tr>
<tr>
<td>Weight (Kg/Km)</td>
<td>1621</td>
<td>≤ 1621</td>
<td>1600</td>
<td>1565</td>
<td>1590</td>
</tr>
<tr>
<td>Voltage (kV)</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
<td>220</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (83 Kg/sq.m) (Kg)</td>
<td>4981</td>
<td>6489</td>
<td>4981</td>
<td>4981</td>
<td>4981</td>
</tr>
<tr>
<td>Ampacity &amp; OT (Amps) &amp; (Deg.c)</td>
<td>550 (75)</td>
<td>1200</td>
<td>1100 (138)</td>
<td>1200 (122.5)</td>
<td>1200 (118.4)</td>
</tr>
</tbody>
</table>

Lesser Sag and Low Operating Temperature than any other technology
**Case Study 132 KV – North India STU**

<table>
<thead>
<tr>
<th>Description</th>
<th>Exiting ACSR Panther Conductor</th>
<th>Need of STU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voltage (Kv)</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td>Ampacity @ 75 deg.c</td>
<td>379</td>
<td>1000</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (45 Kg/sq.m)</td>
<td>2840</td>
<td>2840</td>
</tr>
<tr>
<td>Sag at 75 deg.c – 365 Span</td>
<td>8.83</td>
<td>8.83</td>
</tr>
</tbody>
</table>

More than Double Ampacity than the existing capacity Without Violating the existing Ground Clearance
## Case Study 132 KV – Different Technology

<table>
<thead>
<tr>
<th>Description</th>
<th>ACSR Panther</th>
<th>Need</th>
<th>ACSS</th>
<th>STACIR</th>
<th>CCC</th>
<th>ACFR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diameter (mm)</td>
<td>21</td>
<td>≤ 21</td>
<td>19.66</td>
<td>19.6</td>
<td>20.5</td>
<td>20.75</td>
</tr>
<tr>
<td>Weight (Kg/Km)</td>
<td>974</td>
<td>≤ 974</td>
<td>968</td>
<td>850</td>
<td>835</td>
<td>819</td>
</tr>
<tr>
<td>Voltage (kV)</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
<td>132</td>
</tr>
<tr>
<td>Tension 32 deg. Full wind (45 Kg/sq.m) (Kg)</td>
<td>2840</td>
<td>2840</td>
<td>2840</td>
<td>2712</td>
<td>2724</td>
<td>2840</td>
</tr>
<tr>
<td>Sag at below Amps (Meters) – 365 Span</td>
<td>8.83</td>
<td>8.83</td>
<td>10.65</td>
<td>11.7</td>
<td>7.81</td>
<td>7.79</td>
</tr>
<tr>
<td>Ampacity &amp; OT (Amps) &amp; (Deg.c)</td>
<td>378 (75)</td>
<td>1000</td>
<td>1000 (210)</td>
<td>1000 (250)</td>
<td>1000 (166.6)</td>
<td>1000 (163.8)</td>
</tr>
</tbody>
</table>

Lesser Sag and Low Operating Temperature than any other technology.
Tension Hardware

☑ Similar design and installation equipment to ACSR’s.

**ACSR**

- **Dead End Clamp** (example - Linnet size)
  - 337mm

- **Mid Span Joint** (example - Linnet size)
  - 439mm

**ACFR**

- **Compression Machine Die x 2 set**
  - 495mm

**CCC**

- **Compression Machine Die x 1 set**
- **Torque Wrench for Collet**
- **Mesh Sanding Paper**
  - 790mm
  - 1544mm

Equipment

- Compression Machine
  - Die x 2 set

- Compression Machine
  - Die x 2 set

- Compression Machine
  - Die x 1 set
  - Torque Wrench for Collet
  - Mesh Sanding Paper
Installation of Hardware

Easy installation of fitting process.

Dead end clamp for ACFR
Finish time is
5 minutes 35 seconds

Dead end clamp for ACSR
Finish time is
5 minutes 20 seconds

☆ The video is playing by 4 times speed.
Key Stringing Criteria Comparison

- Similar installation requirements to ACSR’s.

<table>
<thead>
<tr>
<th>Conductor Type</th>
<th>ACFR</th>
<th>ACCC</th>
<th>TACSR</th>
<th>ACSS</th>
<th>ACCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aluminum</td>
<td>Annealed (1350-O)</td>
<td>Thermal Resistant (TA1)</td>
<td>Annealed (1350-O)</td>
<td>Thermal Resistant (TA1)</td>
<td>Annealed (1350-O)</td>
</tr>
<tr>
<td>Bull Wheels</td>
<td>40 x diameter</td>
<td>40 x diameter</td>
<td>40 x diameter</td>
<td>40 x diameter</td>
<td>1828mm Minimum</td>
</tr>
<tr>
<td>Sheaves Wheels</td>
<td>20 x diameter</td>
<td>25-35 x diameter</td>
<td>20 x diameter</td>
<td>20 x diameter</td>
<td>711mm Minimum</td>
</tr>
<tr>
<td>Grips (Pulling)</td>
<td>Kellums</td>
<td>Kellums</td>
<td>Kellums</td>
<td>Kellums</td>
<td>Special Grip</td>
</tr>
<tr>
<td>Grips (Sagging)</td>
<td>Chicago</td>
<td>Chicago</td>
<td>Chicago</td>
<td>Pocketbooks Chicago</td>
<td>Special Grip</td>
</tr>
<tr>
<td>Recommended Pulling Angles</td>
<td>45 degrees</td>
<td>60 degrees</td>
<td>30 degrees</td>
<td>60 degrees</td>
<td>45 degrees</td>
</tr>
<tr>
<td>Dead End Installation Time</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>15 minutes</td>
<td>15 minutes</td>
<td>15 minutes</td>
</tr>
<tr>
<td>Mid Span Joint Installation Time</td>
<td>30 minutes</td>
<td>60 minutes</td>
<td>30 minutes</td>
<td>30 minutes</td>
<td>30 minutes</td>
</tr>
</tbody>
</table>

- In general, the conductors with carbon fiber core shall be handled with care (no drag/scratch, no over twist, no over bend) during installation work. Initial on-site training is available.
Bending Angle (Flexibility)

- Less numbers of stringing works.
- Smaller diameter of sheaves.

**ACFR**: One (1) stringing work

- $a + b < 45^\circ - 60^\circ$
- Smaller sheaves

**CCC**: Three (3) stringing works

- $a + b < 30^\circ$
- Larger sheaves

* Conceptual image
Certification and Testing

Standards

Design Tests
- UTS of Conductor and Core
- Stress Strain Conductor and Core
- Electrical Resistance test
- Creep Test
- Thermal Expansion
- Tg Test
- Flexural Strength
- Elongation

Installation Tests
- Sheave Test
- Bending Test
- Torsion Test
- Radial Crush Test
- Gripping Force

In-service/Operation Performance Tests
- Sag and Tension
- Corrosion
- Heat Exposure test for 52 weeks
- Heat Stress Test
- Temperature Cycle
- Strand Brittle Fracture test
- Fatigue Test
- High Temperature Creep
- UV Aging Test
- Fire retardant test
Supply Record of

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>160/40</td>
<td>160/40</td>
<td>315/35</td>
<td>320/40</td>
<td>315/40</td>
<td>315/40</td>
</tr>
<tr>
<td>Voltage</td>
<td>66kV</td>
<td>66kV</td>
<td>110kV</td>
<td>220kV</td>
<td>150kV</td>
<td>150kV</td>
</tr>
<tr>
<td>Location</td>
<td>Miyagi, Japan</td>
<td>Niigata, Japan</td>
<td>Guangdong, China</td>
<td>Hainan, China</td>
<td>Kalimantan, Indonesia</td>
<td>Medan, Indonesia</td>
</tr>
</tbody>
</table>

The very first carbon core conductor commissioned in the world.
The line is up and running ever since.
# Project Profile: Lower Sagging

## Project Overview

<table>
<thead>
<tr>
<th>Customer</th>
<th>Tohoku Electric Power Co</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Location</td>
<td>Miyagi, Niigata / Japan</td>
</tr>
<tr>
<td>Year Installed</td>
<td>2002</td>
</tr>
<tr>
<td>Conductor Length</td>
<td>3 KM / 2KM</td>
</tr>
<tr>
<td>Voltage</td>
<td>66 kV</td>
</tr>
</tbody>
</table>

## Solution

ACFR 160/40 (Round Shaped Hard Drawn AL)

## Result

- 20% capacity increase while maintaining clearances
- Used existing towers without modification
- Maintained existing right of way
- Saved time for installation

The oldest transmission line using carbon core in the world
### Certification of Operation Record

ACFR: Aluminium Conductor Carbon Fiber Reinforced

Tokyo Electric Power Co., Inc certify the safe operation of Aluminium Conductor Carbon Fiber Reinforced without any problem from the beginning of operation until now as shown below.

<table>
<thead>
<tr>
<th>Table 1: Operation record of ACFR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rated No.</strong></td>
</tr>
<tr>
<td><strong>Name of Branch office</strong></td>
</tr>
<tr>
<td><strong>Line name (open No.)</strong></td>
</tr>
<tr>
<td><strong>Installation date</strong></td>
</tr>
<tr>
<td><strong>Conducting section</strong></td>
</tr>
<tr>
<td><strong>Resistance corning ACFR</strong></td>
</tr>
<tr>
<td><strong>Current Carrying Capacity</strong></td>
</tr>
</tbody>
</table>

#### Conductors information:

- **Conductor composition (%)**
  - Number of conductors: 1
  - Diameter of each conductor: 10.00mm
  - Diameter of ACFR: 10.00mm

#### Electric Characteristics:

- **Voltage**
  - Rated Voltage: 6KV
  - Minimum operating pressure: 400Pa
  - Maximum operating pressure: 950Pa

#### OPERATION CONDITIONS

- **Environment:**
  - Operating conditions: normal ambient conditions
  - Maximum ambient temperature: 40°C
  - Minimum ambient temperature: -10°C

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佐藤 秀治
東京電力株式会社
電力システム本部
電力システム部（送電）
課長 佐藤 秀治

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Project Profile : Ampacity Upgrade

Project Overview

- Customer: China Southern Power Grid
- Project: Hainan Island City
- Location: Hainan Island / China
- Year Installed: 2013 (Energized)
- Conductor Length: 60 KM
- Voltage: 220 kV

Solution

ACFR 320/40 (Trapezoidal Shaped Annealed AL)

Result

- Doubled capacity of line while maintaining clearances
- Used existing towers without modification
- Maintained existing right of way
- Saved time for installation
“倍容导线在海南电网的研究与应用”
项目使用情况报告

2012年海南电网海口供电局根据电网改造要求，对南网特高压项目采用的是倍顾导线

220kV福车线进行了增容技术改造工程，选用的是倍顾导线

JL/XJ-220/40及压接型金具，线路全长18.8km，整个改造工程

用非金属芯复合绝缘软导线39.567km，最大风偏段长度4882米，最大
导线单段试运长度5018米，导线施工周期18天，于2013年7月2日

整个工程安装方便，特别是接线型金具操作简单，安全，快速，
整条线路使用近半年未发生一次问题，经历数次台风洗礼(包括今年
历史上最大台风海燕)，最大电流1940A，弧垂及导线温度参数均符
合设计要求。

我公司对这种导线是第一次使用，从技术参数及安装使用情况来
说，此种导线是一种值得研究使用的新型节能导线。


Hainan Power Grid Corporation,
Haikou Power Distribution Division
Industrial Technology Department
December 1st 2013

(TRANSLATION – Chinese to English)

Re: Project Report for research and applications on double-carrying capacity conductor cable at Hainan Power Grid Corp.

Hainan Power Grid Corp. Haikou Power Distribution Div. conducted revamping of transmission capacity enhancement on 220kV Fufeng Line 1 to comply with electricity users’ demand. JL/XJ-220/40 type conductor cable and accessories, produced by Fugang Xinyuan Hengye Cable Technology Co., Ltd. in Guangdong Province, was used for this project in replacement of existing conductor cable line. JL/XJ-220/40 is type of conductor cable made from soft annealed aluminum, reinforced by carbon fiber composite core, and dead-end clamp to be installed by compression. Route length is 18.8km and total length of conductor cable is 39.567km. The longest span between dead-end clamps is 4,682m. Production unit of conductor cable was 5,018m. Stringing work was done in 18 days and electric current operation has started on July 2nd 2013.

It was reported that stringing work has been done smooth and easy, particularly, installation of dead-end clamp by pressing die has been done simple, quick and safe. After revamping on July 2nd, 2013, although this line was hit by typhoons for many times including the strongest one ever in the history, the line has been in good and safe operation without any problem as of this data. Carrying 1,940A at maximum, sagging, temperature and other requirements have been within designed and satisfactory level.

This was the first time to make use of this conductor cable for our company, and this cable was reconfirmed to be worth while applying for actual operations as new energy-saving type cable, considering various aspects of this cable, including high standard of technology, easy and smooth handling and installation, and actual operational data.
Project Profile: Ampacity Upgrade

Project Overview

Customer: PLN  
Project: Binjai – Pangkalan Brandan  
Location: Medan / Indonesia  
Year Installed: 2015 (Energized) and 2018 (Installing)  
Conductor Length: 350 km for 2015 and 350 km for 2017  
Voltage: 150 kV

Solution

ACFR 315/40 (Trapezoidal Shaped Annealed AL)

Result

Doubled capacity of line while maintaining clearances  
Used existing towers without modification  
Maintained existing right of way  
Saved time for installation
Operation Certification from PLN

Indonesian

PT PLN (PERSERO)

PENYALURAN DAN PUSAT PENGAWAS BESAR SUMATERA

No. : 0382/IKON.02.02/PIHS/2017

Tanggal : 6 Desember 2017

U.p. : Direktur

Menurut surat dari Bauma No. 225/UK/LX/2017 tanggal 06 November 2017 perihal keterangannya bahwa PT Voelkl Electric telah menggunakan bahan HTLS Produk PT Voelkl Electric berupa Nama Kondutor : Aluminum Conductor Fiber Reinforced (ACFR)
Ukuran : 315/40 mm²
Tidak beroperasi sejak : 03 April 2016

Beserta dengan Kontrak No. 0987/PAKON.02.02/P385/2015 tanggal 13 Agustus 2015 penjualan SUTT 150 kV Unitan - Kitasen sistem 1 & 2 (57 kmm) dari ACFR-12035 mm² dengan HSLA kondutor yang kemampuan 2 kali Existing.

Demikian Surat Keterangan ini dibuat untuk dapat dipenggunaan sepenuhnya, senantiasa dan berdasar pada disepakat tenaga kerja.

PLN GENERAL MANAGER
MANAJER UMUM SISTEM

English Translation

Reference No. : 0382/IKON.02.02/PIHS/2017
Nature : Urgent
Regarding : Statement Letter

To: PT Voelkl Electric
Jl. Margoង KM 16, Cileungsi
Bogor 16820

Attention : Director

In replying your letter No 225/UK/LX/2017, Date: 6 November 2017 about request of Success Operation Letter, with this PT PLN (Persero) P38 Sumatera confirmed that HTLS Conductor
Conductor Name : Aluminum Conductor Fiber Reinforced (ACFR)
Size : 315/40 mm²
Commencement Date : 03 April 2016
Contract No. : 0987/PAKON.02.02/P385/2015, Date: 13 August 2015
Project Name : Reconductoring SUTT 150 kV Unitan Tanjung – Kitasen Circuit 1 & 2 (57 kmm) from ACFR-12035 mm² to HSLA Conductor with double the existing capacity.

Was produced by PT Voelkl Electric

This letter of statement shall be used for the right purpose. Thank you for your corporation.

Acting General Manager
Manager of Operation & System

Asy-Samsudin
Our Business Morel with

Conductor Maker

EPC

Electric Company

Providing CFCC gripping Technology

Supervising Hardware installation Stringing work

Supporting ACFR Design ACFR Production
Stringing Support

Stringing Advisor

- Stringing Lecture
- Job Site Observation

Manual to be provided

Stringing

INSTALLATION GUIDELINES/ MANUAL
FOR ACFR (Reference)

ACFR
ALUMINUM CONDUCTOR FIBER REINFORCED

Hardware

Installation Video

Instruction Manual
COMPRESSON TYPE DEAD-END CLAMP
For ACFR 200mm²

Dead-End Clamp Installation for ACFR
Summary

- HTLS solution is attracting attention especially in Asia are

- ACFR is the best solution among HTLS conductor

- ACFR’s hardware and Installation process is close to standard ACSR
Thank you!

TOKYO ROPE INTERNATIONAL INC.