Advanced Conductors: The Steel Core Advantage

The United States is facing an urgent need to rapidly expand its electrical transmission capacity to enable decarbonization goals and accommodate increasing renewable energy sources. However, transmission capacity expansion rates have slowed in recent years due to permitting delays, rising land costs, supply chain issues, and other challenges.

One solution utilities are increasingly using is reconductoring - replacing existing overhead transmission line conductors with advanced conductor technologies (ACTs) that can increase capacity on the existing structures. ACTs introduced since the early 2000s feature ultra-high strength steels that allow higher operating temperatures and lower sag compared to aluminum conductor steel reinforced (ACSR) cables.

While early composite core conductor designs were able to provide capacity increases over conventional ACSR conductors, the latest ultra-high strength steel core ACSS/TW designs now offer even greater capacity ratings, according to the Idaho National Laboratory Advanced Conductor Scan Report. Specifically, the report states that the 959 kcmil Suwannee **ACSS/TW/MA5 conductor provides a 191% increase in maximum continuous ampacity** compared to an equivalent 795 kcmil ACSR - exceeding the 158% increase from the 3M ACCR 795 T16 and the 165% increase from the 1026 kcmil ACCC Drake composite conductors. Details of the graph in the report is listed below.

		History	Mechanical			Capacity	Efficiency/Line Losses		Unit Cost
Conductor Type	Conductor	Year Introduced	More Sag than ACSR	Rated Breaking Strength vs ACSR	Weight vs ACSR	Ampacity @ MOT Continuous vs ACSR	Resistance @ 20˚C vs ACSR	Resistance @ MOT Continuous vs ACSR	Cost vs ACSR
ACSR	795 Drake	1900's	No	100%	100%	100%	100%	100%	100%
3M ACCR	795 T16	2002	No	102%	85%	158%	94%	129%	unknown
ACCC	1029 Drake	2003	No	129%	96%	165%	77%	99%	237%
ACSS/MA5	795 Drake	2007	Yes, @ MOT	103%	100%	174%	97%	146%	108%
ACCS/TW/C7	973 Everglades	2014	No	124%	92%	153%	82%	106%	unknown
ACCC/E3X	1029 Drake	2015	No	129%	97%	186%	77%	99%	237%
ACSS/TW/MA5	959 Suwanee	2015	Yes, @ MOT	123%	121%	191%	80%	121%	139%
ACSS/MA5/E3X	795 Drake	2015	Yes, @ MOT	103%	100%	199%	97%	146%	135%
ACSS/TW/MA5/E3X	959 Suwanee	2015	Yes, @ MOT	123%	121%	218%	80%	121%	152%
TS Conductor	1051 Sun M3	2021	No	129%	129%	129%	129%	129%	unknown

Table 2-6. Conductors listed by year introduced, high temperature sag profile, and other factors.

The report highlights a key advantage of the steel core ACSS/TW designs is that they can **leverage more conventional installation techniques, hardware, and skilled labor pools familiar with ACSR**. In contrast, it notes composite core conductors require special handling and installation procedures due to the potential for damage to the carbon or ceramic fiber cores if mishandled. This increases training requirements and labor costs. The report also cites ongoing **concerns about long-term reliability of some composite core designs** if the core is compromised during installation.

While the report acknowledges composite cores provide excellent weight reduction and low thermal elongation benefits, it states the **ultra-high strength steel alloys used in ACSS/TW achieve competitive sagging performance at high temperatures**. And the trapezoid-shaped aluminum strands maximize aluminum cross-sectional area and conductivity.

Another advantage of steel core conductors like **ACSS/TW highlighted in the report is their ability to be recycled at end-of-life, like conventional ACSR**. The steel and aluminum components can be relatively easily separated and re-melted into new conductor products. In contrast, the **polymer composite cores of conductors like ACCC present recycling challenges**.

So, for **utilities looking to maximize capacity increases on existing transmission corridors through reconductoring, the Idaho National Laboratory report concludes the ACSS/TW designs represent an extremely high-capacity and cost-effective solution** by combining incredible ampacity with installation using conventional ACSR techniques. This avoids some of the fragility and construction complexity concerns associated with composite core conductors cited in the report.