AGENDA INFORMATION SHEET

DEPARTMENT: **Denton Municipal Electric**

CM: **Todd Hileman**

DATE: **May 7, 2018**

SUBJECT

Receive a report from staff regarding the 2017 Reliability Indices for the electric distribution system and DME's actions taken to improve reliability.

BACKGROUND

In the 1940's, electric system disruptions were the norm. In fact, many electric utilities would turn off their generators at night only to restart them again the next day. These outages were expected by their customers who were okay with this level of service.

Today's expectations are different, and understandably so. Electricity is used for nearly every activity. Electric utility customers expect electricity to be available, literally, at the flip of a switch 365/7/24. It is key to productivity and profitability for industries and businesses, maintaining life at hospitals and emergency rooms, and cooling/heating, cooking, and entertainment in our homes. The reality is, at all levels of electric service – whether its generation, transmission, substation, or distribution – the system is imperfect and experiences occasional service anomalies and outages. DME understands, even though the system is imperfect, we have a responsibility to provide reliable service so when issues arise, response is quick to restore service.

Response is not the only action needed or taken. Behind the scene are engineers, linemen, and system operators working to gain in-depth understanding of the causes and prepare actions plans to address, and minimize, future service irregularities. The most significant tool in this arsenal for understanding, and addressing issues, is the Outage Management System (OMS). There are a number of ways for DME to be notified of an outage. If an event occurs at the transmission or substation level – such as a breaker lockout - relays in the substations will report this, through SCADA, to the OMS. However, events that occur past the distribution relays, in the past, relied solely on customer calls to provide notification. Three (3) years ago, the Engineering & Operational Technology group at DME completed integration of the AMI system into the OMS. This action greatly improved the notification process to system operations and provides for identification of a more exact location for the causal incident. OMS delivers a visual report of an event on DME's GIS mapping system. The OMS includes logic that provides system operators with the vicinity of the causal incident so crews can be dispatched accordingly. It is the data collected by the OMS that allows DME engineers to understand the operation of the distribution system.

The Institute of Electrical and Electronic Engineers (IEEE) offers the governance for practice standards related to electric utilities such as the *National Electrical Safety Code*. Two primary standards, IEEE 1366 – *IEEE Guide for Electric Power Distribution Reliability Indices,* and IEEE 1782 – *IEEE Guide for Collecting, Categorizing, and Utilizing Information Related to Electric Power Distribution Interruption Events* give approaches for collecting and categorizing power anomalies that occur on the electric distribution system. It is important to note that, even though these documents are considered a "Standard", there is no legal or regulatory requirement for any electric utility to follow the practices within. DME's approach is to be in compliance with the practices and procedures for determination of reliability indices that the documents put forth. Each index focuses on what IEEE 1366 classifies an "outage" as. DME adheres to the Standard with one exception for the definition of an outage. DME uses 1 minute which is a narrower bandwidth than the 5 minutes which is an industry practice. It is important to recognize all outages, which are greater than 1 minute, are counted including outages taken by DME crews to perform maintenance or construction activities.

The first Standard, IEEE 1366, establishes the indices, and methodology to calculate, electric utilities could use. There are a number of indices utilities can calculate; but there are four (4) principal indices every utility calculates. These indices, along with their description and units of measure, are:

1) System Average Interruption Duration Index (SAIDI): This index measures the total duration of an interruption for the average customer during the period being studied. This index's units are minutes.
2) Customer Average Interruption Duration Index (CAIDI): This index measures the average time it takes for service to be restored during the period being studied. This index's units are minutes.
3) System Average Interruption Frequency Index (SAIFI): This index is the average number of times a system customer experiences an outage during the period being studied. This index has no units.
4) Average Service Availability Index (ASAI): This index is the ratio of the total number of customer hours that service was available during the period being studied. This index's has no units but results in a percentage.

As an additional index, DME Engineering ranks its substations and feeders performance. Performance is calculated by multiplying duration (SAIDI) by frequency (SAIFI). The higher the result, the lower in performance. Performance is not IEEE 1366 but is an unbiased method to provide understanding of how well each component of the electric distribution system is performing compared to its counterparts. SAIDI is the principal index studied when comparing utility peers to one another, and is what the Public Utility Commission of Texas focuses on in its decisions or rule making.

The second Standard, IEEE 1782, provides direction on data to be collected during the interruption process such as responsible system (generation, substation, transmission, distribution overhead or underground, or customer equipment); causative classification coding; equipment failure coding, and interruption devices for each outage. Attachment A to this document provides the classification codes for causes and equipment used by DME. For each event, these codes are recorded into the OMS system – which is the system of record for reliability events and service restoration. DME does compare its reliability indices to the national and state averages, other large municipal electric utilities in Texas, our local competitors including CoServ Electric and Oncor, and our fellow TMPA members. This information is obtained through an annual report generated, and released, by the United States Energy Information Administration. IEEE 1782's direction allows each utility to collect data in a relatively common fashion, but also allows the utility to be as detailed as it wants to be. This is why a true apples-to-apples comparison between utilities in not possible.

There are three emphases in a reliability study: 1) the number of events, 2) the amount of time (HH:MM:SS), and 3) the customers affected. The data stored in the OMS database, along with the substation and/or feeder, cause and equipment codes, customer addresses, and system operations and field comments provides for the in-depth analysis performed by engineering. During the study period of January 1, 2017 to December

31, 2017 (2017 Study Period), DME recorded 950 events with an accumulated total time of 1474:30:21 (HH:MM:SS), and 48,206 customers affected. This data was analyzed at a system, substation, and feeder level. The analysis allowed for ranking the substations and feeders in performance. The higher the result due to the performance calculation (performance = SAIDI X SAIFI), the worst that substation or feeder is ranked. DME's top 10 worst performing feeders are identified through this same calculation. All substations and feeders get studied based on their causes and equipment to determine potential action plans to alleviate or minimize future events. The worst performers; however, get more a focused review to understand if events have commonality or exclusivity. Even though equipment is reviewed, cause codes are fundamental in the development of action plans.

For the 2017 Study Period, there was commonality of causes. The top five (5) causes attributed to 654 out of 950 events (69%), 1032:29:08 out of a total time of 1474:30:21 (70%), affecting 33,147 customers of the 48,206 total customers affected (69%). The top 5 are:

1) Small animals (cause code 600) were the cause of 213 events with squirrels tied to 199 of these events. Small animals accounted for 289:40:32, and affected 11,467 customers.
2) Maintenance (cause code 110) was the cause of 179 events which accounted for 224:13:07 and 2,647 customers affected.
3) Decay/age of material/equipment (cause code 400) was the cause of 98 events which accounted for 251:12:04 and affected 4,745 customers.
4) Lightning (cause code 500) was the cause of 86 events which accounted for 129:08:04 and affected 9,356 customers.
5) Material or equipment failure (cause code 300) was the cause of 78 events which accounted for 138:15:21 and affected 4,932 customers.

DME's action plan focuses on these five causes. Feeder sweeps have been completed in the area identified as being the most affected by the top 5. Feeder sweeps, which started wholehearted in the October 2017 timeframe, included replacement, or installation of, animal protection on equipment prone to failure due to small animals. DME has moved to a new provider of animal protection. This equipment appears to be a superior product than the product used before. This product is easier to install by the linemen, but is more difficult to remove, or "pop off." Additionally, the product is more fire proof so issues, such as faults, have a better chance to be contained thus minimizing a potential spread of the fault to a catastrophic level. Equipment getting animal protection includes transformers, risers, switches, capacitor banks, and lightning arrestors. The issue of having squirrels and other small rodents burrowing into risers and chewing on the cable to failure is addressed with the replacement of riser foam with metal duct plugs. Areas have been reviewed for vegetation management, and where needed, trees were re-trimmed to discourage small animals from jumping from trees to the power lines. Distribution technology has been introduced with "smart fuses" being installed at locations deemed appropriate. Poles, transformers, and other appurtenances have been inspected with damaged or missing equipment being replaced. DME has also investigated the use of less conventional approaches also such as fox urine. Even though there is not enough data at this time to confirm this, it is believed these actions have significantly reduced events and improved the reliability in the targeted areas.

DME is looking for ways to improve its system reliability as a continual process. There will always be worst performing feeders. Nevertheless, DME is committed to work to improve the values associated with the reliability indices, SAIFI, CAIFI, and SAIDI. DME must continually look for new products or applications that minimize the effects of causes that our out of our control, such as squirrels and lightning.

It is easy to see the next generation of electric distribution systems will be capable of increased performance and reduced outage time through distribution automation, or as it is commonly called the "smart grid." DME is reviewing all of its field control devices on the distribution system, and when appropriate, preparing them to be Intelligent Electric Devices (IED's) capable of real-time data transmission and event monitoring back to a head-end system called an Advanced Distribution Management System (ADMS). These are the

systems that will make Denton's "self-healing grid" possible. A simplistic approach to ADMS' value is it will minimize the amount of time customers experience an outage (restores service to as many as possible while isolating the cause of the fault); can increase the efficiency (and lower the cost of energy) of the distribution system operation by applying counter measures to operational issues such as power factor and low voltage; and give DME engineers, system operators, and maintenance staff real-time data on the overall health of the system.

FISCAL INFORMATION

This has no financial association.

STRATEGIC PLAN RELATIONSHIP

The City of Denton's Strategic Plan is an action-oriented road map that will help the City achieve its vision. The foundation for the plan is the five long-term Key Focus Areas (KFA): Organizational Excellence; Public Infrastructure; Economic Development; Safe, Livable, and Family-Friendly Community; and Sustainability and Environmental Stewardship. While individual items may support multiple KFAs, this specific City Council agenda item contributes most directly to the following KFA and goal:

Related Key Focus Area: **Public Infrastructure**
Related Goal: **2.3 Promote superior utility services and City facilities**

EXHIBITS

Exhibit 1 – Agenda Information Sheet
Exhibit 2 – DME Classifications (IEEE 1782) for Cause and Equipment
Exhibit 3 – Presentation

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Attachment A
Denton Municipal Electric
Cause and Equipment Coding

Cause Code			Equipment Code			Weather Code	
Category	Code	Definition	Catergory	Code	Definition	Code	Definition
Power Supply	000	Power supply	Generation or Transmission	010	Generation	010	Rain
Planned Outage	100	Construction	Generation or Transmission	020	Towers, poles, and fixtures	020	Lightning
Planned Outage	110	Maintenance	Generation or Transmission	030	Conductors and devices	030	Wind
Planned Outage	190	Other planned	Generation or Transmission	040	Transmission substations	040	Snow
Equipment or Installation/Design	300	Material or equipment failure	Generation or Transmission	090	Generation or transmission, other	050	Ice
Equipment or Installation/Design	310	Installation fault	Distribution Substation	100	Power transformer	060	Sleet
Equipment or Installation/Design	320	Conductor sag or inadequate clearance	Distribution Substation	110	Voltage regulator	070	Extreme Cold
Equipment or Installation/Design	340	Overload	Distribution Substation	120	Lightning arrester	080	Extreme Heat
Equipment or Installation/Design	350	Miscoordination of protection devices	Distribution Substation	130	Source side fuse	090	Weather, other
Equipment or Installation/Design	360	Other equipment installation/design	Distribution Substation	140	Circuit breaker	100	Calm
Maintenance	400	Decay/age of material/equipment	Distribution Substation	150	Switch		
Maintenance	410	Corrosion/abrasion of material/equipment	Distribution Substation	160	Metering equipment		
Maintenance	420	Tree growth	Distribution Substation	190	Distribution substation, other		
Maintenance	430	Tree failure from overhang or dead tree without ice/snow	Poles & Fixtures Distribution	200	Pole		
Maintenance	440	Trees with ice/snow	Poles & Fixtures Distribution	210	Crossarm or crossarm brace		
Maintenance	450	Contamination (leakage/external)	Poles & Fixtures Distribution	220	Anchor or guy		
Maintenance	460	Moisture	Poles & Fixtures Distribution	290	Poles & fixtures, other		
Maintenance	470	Borrower crew cuts tree	Overhead Line Conductors and Devices, Distribution	300	Line conductor		
Maintenance	490	Maintenance, other	Overhead Line Conductors and Devices, Distribution	310	Connector or clamp		
Weather	500	Lightning	Overhead Line Conductors and Devices, Distribution	320	Splice or deadend		
Weather	510	Wind, not trees	Overhead Line Conductors and Devices, Distribution	330	Jumper		
Weather	520	Ice, sleet, frost, not trees	Overhead Line Conductors and Devices, Distribution	340	Insulator		
Weather	530	Flood	Overhead Line Conductors and Devices, Distribution	350	Lightning arrester, line		
Weather	590	Weather, other	Overhead Line Conductors and Devices, Distribution	360	Fuse cutout (damaged, malfunction, maintenance)		
Animals	600	Small animal/bird	Overhead Line Conductors and Devices, Distribution	370	Recloser or sectionalizer (damaged, malfunction, maintenance)		
Animals	610	Large animal	Overhead Line Conductors and Devices, Distribution	390	Overhead line conductors and devices, other		
Animals	620	Animal damage - gnawing or boring	Underground Line Conductors and Devices, Distribution	400	Primary Cable		
Animals	690	Animal, other	Underground Line Conductors and Devices, Distribution	410	Splice or fitting		
Public	700	Customer caused	Underground Line Conductors and Devices, Distribution	420	Switch		
Public	710	Motor vehicle	Underground Line Conductors and Devices, Distribution	430	Elbow arrester		
Public	720	Aircraft	Underground Line Conductors and Devices, Distribution	440	Secondary cable or fittings		
Public	730	Fire	Underground Line Conductors and Devices, Distribution	450	Elbow		
Public	740	Public cuts tree	Underground Line Conductors and Devices, Distribution	460	Pothead or terminator		
Public	750	Vandalism	Underground Line Conductors and Devices, Distribution	490	Underground, other		
Public	760	Switching error or cause by construction/maintenance activities	Line Transformer	500	Transformer, bad		
Public	790	Public, other	Line Transformer	510	Transformer fuse or breaker		
Other	800	Other	Line Transformer	520	Transformer arrester		
Unknown	999	Cause Unknown	Line Transformer	590	Line transformer, other		
			Secondary and Services	600	Secondary or service conductor		
			Secondary and Services	610	Metering equipment		
			Secondary and Services	620	Security or street light		
			Secondary and Services	690	Secondary and service, other		
			No equipment damaged	999	No damaged equipment		