Generation Interconnection
Revised System Impact Study Report

For

PJM Generation Interconnection Request
Queue Position AD1-119

Payne 69kV

December 2020

Preface

The intent of the System Impact Study is to determine a plan, with approximate cost and construction time estimates, to connect the subject generation interconnection project to the PJM network at a location specified by the Interconnection Customer. As a requirement for interconnection, the Interconnection Customer may be responsible for the cost of constructing: (1) Direct Connections, which are new facilities and/or facilities upgrades needed to connect the generator to the PJM network, and (2) Network Upgrades, which are facility additions, or upgrades to existing facilities, that are needed to maintain the reliability of the PJM system. All facilities required for interconnection of a generation interconnection project must be designed to meet the technical specifications (on PJM web site) for the appropriate transmission owner.

In some instances a generator interconnection may not be responsible for 100% of the identified network upgrade cost because other transmission network uses, e.g. another generation interconnection or merchant transmission upgrade, may also contribute to the need for the same network reinforcement.

The System Impact Study estimates do not include the feasibility, cost, or time required to obtain property rights and permits for construction of the required facilities. The project developer is responsible for the right of way, real estate, and construction permit issues. For properties currently owned by Transmission Owners, the costs may be included in the study.

General

Timber Road Solar Park, LLC proposes to install PJM Project #AD1-119, a 49.9 MW (18.96 MW Capacity) solar generating facility in Paulding County, Ohio (see Figure 1). The point of interconnection is a direct connection to AEP's Payne 69 kV substation.

The requested in Backfeed date is August 1, 2020.

The requested in service date is October 31, 2020.

Attachment Facilities

Point of Interconnection (Payne 69kV Substation)

To accommodate the interconnection at the Payne 69 kV substation, modify/expand the existing Payne 69kV substation requiring the installation of a new 69 kV circuit breaker (see Figure 2). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 kV revenue metering will also be required. AEP reserves the right to specify the final acceptable configuration considering design practices, future expansion, and compliance requirements.

Direct Connection at the Payne 69 kV Substation Work and Cost:

- Expand the substation requiring the installation of one (1) new 69 kV circuit breaker (see Figure 1). Installation of associated protection and control equipment, 69 kV line risers, SCADA, and 69 kV revenue metering will also be required.
- **Estimated Station Cost: $1,000,000**
- **Note:** Blue Harvest may be required to go offline for routine circuit breaker maintenance.

Non-Direct Connection Cost Estimate

The total preliminary cost estimate for Non-Direct Connection work is given in the following table below:

For AEP building Non-Direct Connection cost estimates:

Description	Estimated Cost
69 kV Revenue Metering	$200,000
Upgrade line protection and controls at the Payne 69 kV substation.	$200,000
Total	**$400,000**

Table 1

Interconnection Customer Requirements

It is understood that Timber Road Solar Park is responsible for all costs associated with this interconnection. The cost of Timber Road Solar Park's generating plant and the costs for the line connecting the generating plant to the Payne 69 kV substation are not included in this report; these are assumed to be Timber Road Solar Park's responsibility.

The Generation Interconnection Agreement does not in or by itself establish a requirement for American Electric Power to provide power for consumption at the developer's facilities. A separate agreement may be reached with the local utility that provides service in the area to ensure that infrastructure is in place to meet this demand and proper metering equipment is installed. It is the responsibility of the developer to contact the local service provider to determine if a local service agreement is required.

Requirement from the PJM Open Access Transmission Tariff:

1. An Interconnection Customer entering the New Services Queue on or after October 1, 2012 with a proposed new Customer Facility that has a Maximum Facility Output equal to or greater than 100 MW shall install and maintain, at its expense, phasor measurement units (PMUs). See Section 8.5.3 of Appendix 2 to the Interconnection Service Agreement as well as section 4.3 of PJM Manual 14D for additional information.

2. The Interconnection Customer may be required to install and/or pay for metering as necessary to properly track real time output of the facility as well as installing metering which shall be used for billing purposes. See Section 8 of Appendix 2 to the Interconnection Service Agreement as well as Section 4 of PJM Manual 14D for additional information.

Revenue Metering and SCADA Requirements

PJM Requirements

The Interconnection Customer will be required to install equipment necessary to provide Revenue Metering (KWH, KVARH) and real time data (KW, KVAR) for IC's generating Resource. See PJM Manuals M-01 and M-14D, and PJM Tariff Sections 24.1 and 24.2.

AEP Requirements

The Interconnection Customer will be required to comply with all AEP Revenue Metering Requirements for Generation Interconnection Customers. The Revenue Metering Requirements may be found within the "Requirements for Connection of New Facilities or Changes to Existing Facilities Connected to the AEP Transmission System" document located at the following link:

http://www.pjm.com/~/media/planning/plan-standards/private-aep/aep-interconnection-requirements.ashx

Network Impacts

The Queue Project AD1-119 was evaluated as a 49.9 MW (Capacity 19.0 MW) injection into the Payne 69 kV substation in the AEP area. Project AD1-119 was evaluated for compliance with applicable reliability planning criteria (PJM, NERC, NERC Regional Reliability Councils, and Transmission Owners). Project AD1-119 was studied with a commercial probability of 100%. Potential network impacts were as follows:

Summer Peak Analysis – 2021

Generator Deliverability

(Single or N-1 contingencies for the Capacity portion only of the interconnection)

None

Multiple Facility Contingency

(Double Circuit Tower Line, Fault with a Stuck Breaker, and Bus Fault contingencies for the full energy output)

1. (FE - FE) The 02RICHLD-02NAOMI 138 kV line (from bus 239070 to bus 238521 ckt 1) loads from 99.83% to 103.08% (AC power flow) of its emergency rating (194 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-3-TE-138-005T'. This project contributes approximately 3.26 MW to the thermal violation.

```
CONTINGENCY 'ATSI-P2-3-TE-138-005T'                    /* RICHLAND 13246
BREAKER (RIDGEVILLE)
  DISCONNECT BUS 239061                          /* 02RDGVL+ 138
  REDUCE BUS 239269 SHUNT BY 100 PERCENT                 /* 02RICHLJ 138
  DISCONNECT BUS 239065                          /* 02RICHG2&3 13
  DISCONNECT BUS 238522                          /* 02RCHLN 69
  DISCONNECT BUS 239060                          /* 02RDGVL 138
  DISCONNECT BRANCH FROM BUS 239269 TO BUS 242993 CKT 1        /* 02RICHLJ
138 05E.LPSC 138
  DISCONNECT BRANCH FROM BUS 239269 TO BUS 238511 CKT 1        /* 02RICHLJ
138 02GMC-J 138
  DISCONNECT BUS 238511                          /* 02GMC-J 138
  DISCONNECT BUS 238556                          /* 02AYERSV 138
  END
```

Contribution to Previously Identified Overloads

(This project contributes to the following contingency overloads, i.e. "Network Impacts", identified for earlier generation or transmission interconnection projects in the PJM Queue)

1. (FE - FE) The 02RICHLD-02NAOMI 138 kV line (from bus 239070 to bus 238521 ckt 1) loads from 103.66% to 106.91% (AC power flow) of its emergency rating (194 MVA) for the

line fault with failed breaker contingency outage of 'ATSI-P2-4-TE-138-002T'. This project contributes approximately 3.26 MW to the thermal violation.

```
CONTINGENCY 'ATSI-P2-4-TE-138-002T'                    /* RICHLAND 13249
BREAKER (LJ TIE)
  DISCONNECT BUS 239065                                /* 02RICHG2&3 13
  DISCONNECT BUS 238522                                /* 02RCHLN 69
  DISCONNECT BUS 238556                                /* 02AYERSV 138
  DISCONNECT BUS 238511                                /* 02GMC-J 138
  DISCONNECT BRANCH FROM BUS 239269 TO BUS 239070 CKT ZB      /* 02RICHLJ
138 02RICHLD 138
  DISCONNECT BUS 242993                                /* 05E.LPSC 138
  END
```

Please refer to Appendix 2 for a table containing the generators having contribution to this flowgate.

2. (FE - FE) The 02RICHLD-02NAOMI 138 kV line (from bus 239070 to bus 238521 ckt 1) loads from 103.4% to 106.64% (AC power flow) of its emergency rating (194 MVA) for the bus fault outage of 'ATSI-P2-2-TE-138-003T'. This project contributes approximately 3.26 MW to the thermal violation.

```
CONTINGENCY 'ATSI-P2-2-TE-138-003T'                    /* RICHLAND 138 J BUS
  REDUCE BUS 239269 SHUNT BY 100 PERCENT               /* 02RICHLJ 138
  DISCONNECT BUS 239065                                /* 02RICHG2&3 13
  DISCONNECT BUS 238522                                /* 02RCHLN 69
  DISCONNECT BRANCH FROM BUS 239070 TO BUS 239269 CKT ZB      /*
02RICHLD 138 02RICHLJ 138
  DISCONNECT BRANCH FROM BUS 239269 TO BUS 239060 CKT 1       /* 02RICHLJ
138 02RDGVL 138
  DISCONNECT BUS 238556                                /* 02AYERSV 138
  DISCONNECT BUS 238511                                /* 02GMC-J 138
  DISCONNECT BRANCH FROM BUS 239269 TO BUS 242993 CKT 1       /* 02RICHLJ
138 05E.LPSC 138
  DISCONNECT BUS 239269                                /* 02RICHLJ 138
  END
```

Steady-State Voltage Requirements

(Results of the steady-state voltage studies should be inserted here)

None

Stability and Reactive Power Requirement

(Results of the dynamic studies should be inserted here)

The reactive power capability of AD1-119 meets the 0.95 lagging and leading PF requirement at the high side of the main transformer.

It was found that:

- AC1-167 was tripped due to the undervoltage relay operation in P1.08 ~ P1.13 and P4.09 ~ P4.14 at South Hicksville 69 kV station. The tripping issues were resolved for P1.08, P1.09, P1.10, P1.12, and P1.13 by reducing clearing time of relays at South Hicksville 69 kV station based on the correspondence with the TO. However, AC1-167 still tripped for contingencies P1.11 and P4.09 ~ P4.14. The detail history of clearing time change is summarized in Table 4 and 5.
    - For contingencies P4.09 ~ P4.14, positive sequence fault impedance was derived from a separate short circuit case and the tripping of AC1-167 was resolved.
    - For contingency P1.11, the contingency was tested on AC1-167 base case and the tripping issue was not resolved. If the primary clearing time for the relay at Mark Center 69 kV on South Hicksville circuit is reduced to 35.5 cycles, the tripping issue can be resolved.
- For P1.01~P1.13 and P4.06 ~ P4.08 contingencies, active power of Timber Unit 1C wind turbine was insufficiently damped, less than 3% damping, during post-fault recovery period. Similar response was observed during AC1-176 system impact study phase. Therefore, the insufficient damping is a pre-existing issue and not caused by the addition of AD1-119.

  All other contingencies met the evaluation criteria.

For contingency P1.11, if the primary clearing time for the relay at Mark Center 69 kV on South Hicksville circuit is reduced to 35.5 cycles, the AC1-167 tripping issue can be resolved. Should AC1-167 and AD1-119 proceed to the facility study stage, a protection system upgrade cost estimate for S Hicksville – Mark Center 69 kV and possibly other adjacent facilities as necessary for protection coordination should be included in the interconnection costs.

Short Circuit

(Summary of impacted circuit breakers)

New circuit breakers found to be over-duty:

None

Affected System Analysis & Mitigation

LGEE Impacts:

None

MISO Impacts:

MISO Impacts to be determined during later study phases (as applicable).

Duke, Progress & TVA Impacts:

None

OVEC Impacts:

None

Delivery of Energy Portion of Interconnection Request

PJM also studied the delivery of the energy portion of this interconnection request. Any problems identified below are likely to result in operational restrictions to the project under study. The developer can proceed with network upgrades to eliminate the operational restriction at their discretion by submitting a Merchant Transmission Interconnection request.

Only the most severely overloaded conditions are listed. There is no guarantee of full delivery of energy for this project by fixing only the conditions listed in this section. With a Transmission Interconnection Request, a subsequent analysis will be performed, which will study all overload conditions associated with the overloaded element(s) identified.

None

New System Reinforcements

(Upgrades required to mitigate reliability criteria violations, i.e. Network Impacts, initially caused by the addition of this project generation)

None

Contribution to Previously Identified System Reinforcements

(Overloads initially caused by prior Queue positions with additional contribution to overloading by this project. This project may have a % allocation cost responsibility which will be calculated and reported for the Impact Study)
(Summary form of Cost allocation for transmission lines and transformers will be inserted here if any)

1. To resolve the Richland – Naomi 138 kV line overloads:

   2019 baseline upgrade B2875 resolves the overloads. The project will relocate the Richland to Ridgeville 138KV line from Richland J bus to K, extend the K bus and install a new breaker. Estimated Project cost is $1.7 million.

   AD1-119 has no cost respoinsibility for this upgrade.

   B2875 went into service in 2019. The upgrade is complete.

Schedule

It is anticipated that the time between receipt of executed agreements and Commercial Operation may range from 12 to 18 months if no line work is required. If line work is required, construction time would be between 24 to 36 months after signing an interconnection agreement.

Note: The time provided between anticipated normal completion of System Impact, Facilities Studies, subsequent execution of ISA and ICSA documents, and the proposed Backfeed Date is shorter than usual and may be difficult to achieve.

Conclusion

Based upon the results of this System Impact Study, the construction of the 49.9 MW (18.96 MW Capacity) solar generating facility of Timber Road Solar Park (PJM Project #AD1-119) will require the following additional interconnection charges. This plan of service will interconnect the proposed generating facility in a manner that will provide operational reliability and flexibility to both the AEP system and the Timber Road Solar Park generating facility.

Cost Breakdown for Point of Interconnection (Payne 69 kV Substation)		
Attachment Cost	Expand Payne 69 kV Substation	$1,000,000
Non-Direct Connection Cost Estimate	69 kV Revenue Metering	$200,000
	Upgrade line protection and controls at the Payne 69 kV substation.	$200,000
	Protection system upgrades for S Hicksville – Mark Center 69 kV and possibly other adjacent facilities as necessary for protection coordination will have to be reviewed in the Facilities Study.	To be determined in the Facilities Study
	Total Estimated Cost for Project AD1-119	**$1,400,000**

Table 2

The estimates are preliminary in nature, as they were determined without the benefit of detailed engineering studies. Final estimates will require an on-site review and coordination to determine final construction requirements.

Figure 1: Point of Interconnection (Payne 69 kV Substation)

Single Line Diagram

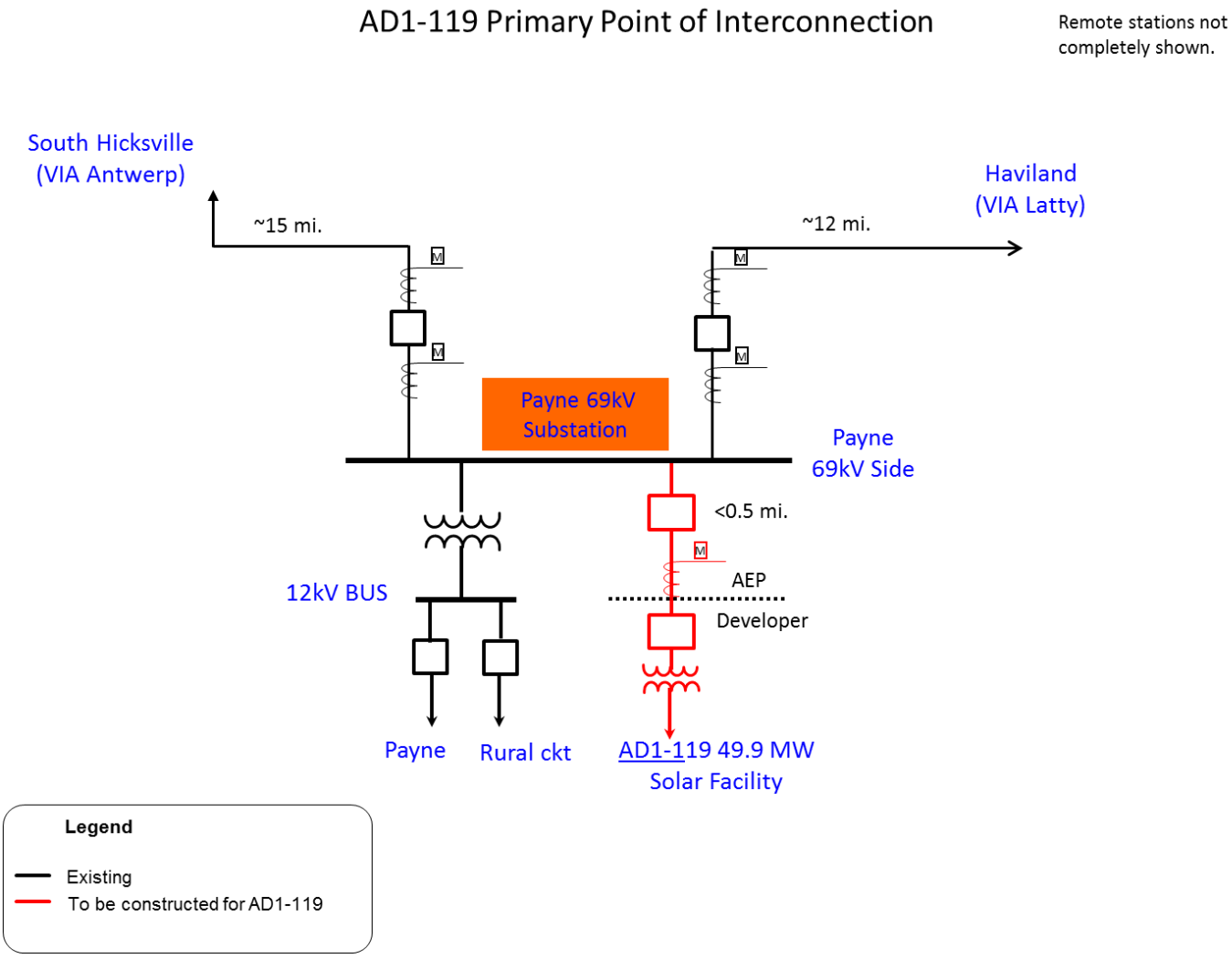
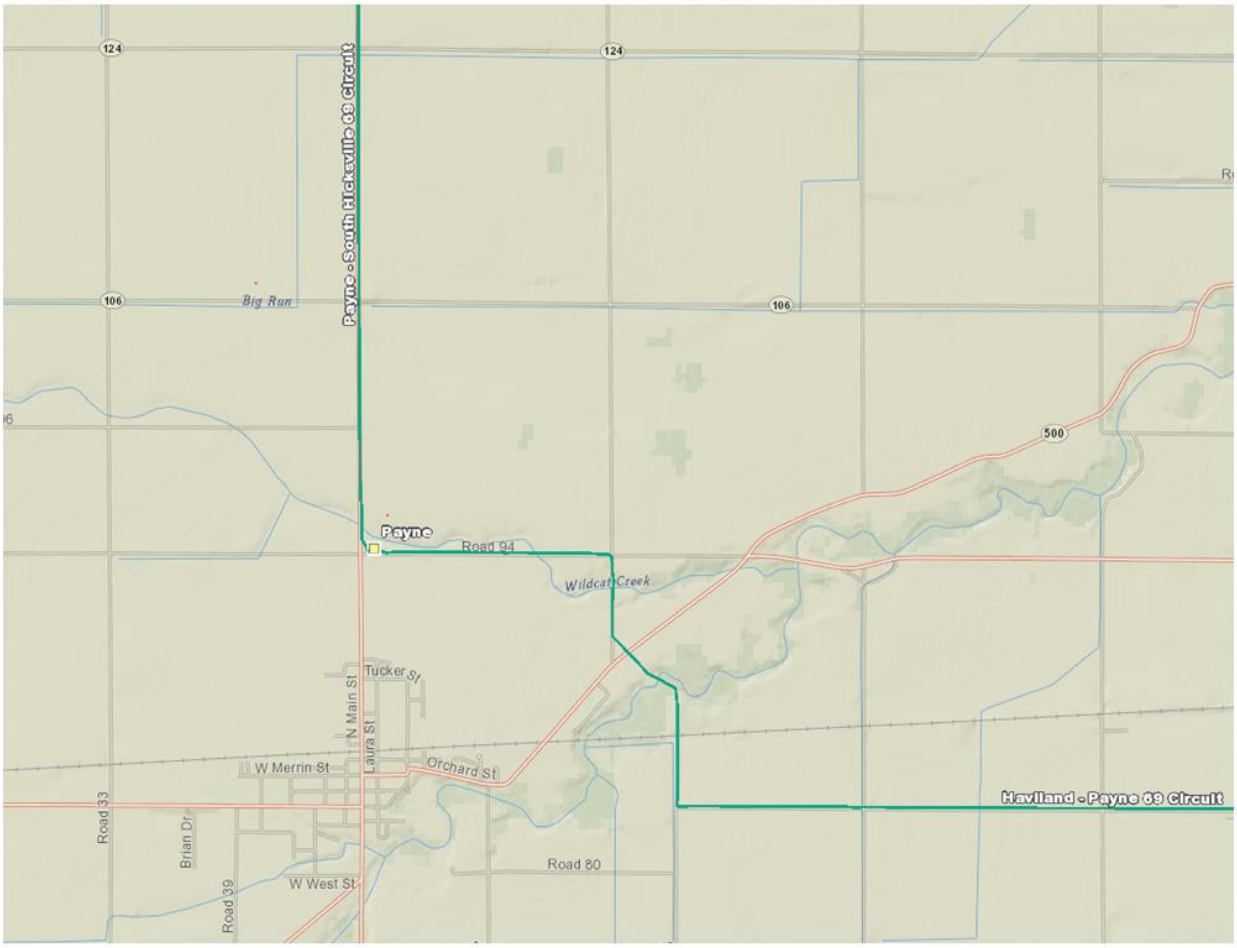


Figure 2: Point of Interconnection (Payne 69 kV Substation)



Appendices

The following appendices contain additional information about each flowgate presented in the body of the report. For each appendix, a description of the flowgate and its contingency was included for convenience. However, the intent of the appendix section is to provide more information on which projects/generators have contributions to the flowgate in question. All New Service Queue Requests, through the end of the Queue under study, that are contributors to a flowgate will be listed in the Appendices. Please note that there may be contributors that are subsequently queued after the queue under study that are not listed in the Appendices. Although this information is not used "as is" for cost allocation purposes, it can be used to gage the impact of other projects/generators.

It should be noted the project/generator MW contributions presented in the body of the report and appendices sections are full contributions, whereas the loading percentages reported in the body of the report, take into consideration the commercial probability of each project as well as the ramping impact of "Adder" contributions.

Appendix 2

(FE - FE) The 02RICHLD-02NAOMI 138 kV line (from bus 239070 to bus 238521 ckt 1) loads from 103.66% to 106.91% (AC power flow) of its emergency rating (194 MVA) for the line fault with failed breaker contingency outage of 'ATSI-P2-4-TE-138-002T'. This project contributes approximately 3.26 MW to the thermal violation.

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DISCONNECT BUS 242993 /* 05E.LPSC 138
END

Bus Number	Bus Name	Full Contribution
240968	02BG2 GEN	-0.36
239064	02RICHG1	1.13
239067	02RICHG4	12.09
239068	02RICHG5	12.09
239069	02RICHG6	12.09
934901	AD1-119 C O1	1.24
934902	AD1-119 E O1	2.02
LTF	CARR	0.17
LTF	CBM-S1	1.07
LTF	CBM-S2	0.29
LTF	CBM-W1	0.28
LTF	CBM-W2	8.58
LTF	CIN	1.49
LTF	CPLE	0.04
LTF	DEARBORN	1.91
LTF	G-007	0.31
LTF	IPL	1.
LTF	LGEE	0.22
LTF	MEC	2.9
LTF	O-066	1.05
LTF	RENSSELAER	0.13
LTF	ROSETON	0.96
LTF	WEC	0.48
926811	AC1-167 C	2.38
926812	AC1-167 E	1.16
926941	AC1-181	2.49