# Sutphen Rear Mount Aerial Ladder (SLR) Project

December 2014

What can we add to our product line to provide our sales force a more robust ability to meet the needs of fire departments that they service?

# Add to our product offering, vehicles that are selling the most, that we don't already offer.

## FAMA Statistics 2011-2015

| Vehicle Classification: | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2011 Totals | | 2012 Totals | | 2013 Totals | | 2014 Totals | | 2015 Totals | | 5 Year Average | |
| Aerial Ladder waterway 0-94 Mid | 9 | 2.0% | 14 | 2.9% | 17 | 3.5% | 29 | 5.5% | 17 | 2.6% | 17.2 | |
| Aerial Ladder waterway 0-94 Rear | 122 | 27.6% | 111 | 23.2% | 117 | 24.2% | 109 | 20.6% | 139 | 21.2% | 119.6 | 136.8 |
| | | | | | | | | | | | | |
| Aerial Ladder waterway 95 + Mid | 11 | 2.5% | 7 | 1.5% | 12 | 2.5% | 11 | 2.1% | 14 | 2.1% | 11 | |
| Aerial Ladder waterway 95 + Rear | 96 | 21.7% | 131 | 27.3% | 112 | 23.2% | 125 | 23.6% | 169 | 25.7% | 126.6 | 137.6 |
| | | | | | | | | | | | | |
| Aerial Platform, 0-85 Mid | 38 | 8.6% | 15 | 3.1% | 24 | 5.0% | 20 | 3.8% | 17 | 2.6% | 22.8 | |
| Aerial Platform, 0-85 Rear | 11 | 2.5% | 4 | 0.8% | 12 | 2.5% | 15 | 2.8% | 9 | 1.4% | 10.2 | 33 |
| | | | | | | | | | | | | |
| Aerial Platform, 86 + Mid | 31 | 7.0% | 57 | 11.9% | 52 | 10.8% | 51 | 9.6% | 59 | 9.0% | 50 | |
| Aerial Platform, 86 + Rear | 69 | 15.6% | 100 | 20.9% | 92 | 19.0% | 103 | 19.5% | 143 | 21.8% | 101.4 | 151.4 |
| | | | | | | | | | | | | |
| Aerial Platform, Articulating | 16 | 3.6% | 6 | 1.3% | 5 | 1.0% | 6 | 1.1% | 9 | 1.4% | 8.4 | |
| Tractor-Drawn Aerial waterway | 30 | 6.8% | 27 | 5.6% | 27 | 5.6% | 54 | 10.2% | 60 | 9.1% | 39.6 | |
| Water Tower, Articulating | 2 | 0.5% | 2 | 0.4% | 3 | 0.6% | 2 | 0.4% | 5 | 0.8% | 2.8 | |
| Water Tower, Telescoping with ladder | 7 | 1.6% | 5 | 1.0% | 10 | 2.1% | 4 | 0.8% | 16 | 2.4% | 8.4 | |
| Totals | 442 | | 479 | | 483 | | 529 | | 657 | | | |

Aerials under 94' : mid-mount 12.5%
rear-mount 87.5%

Aerials over 94' : mid-mount 8%
rear-mount 92%

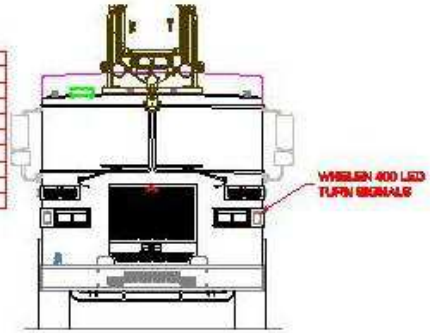
# Rear Mounted Aerials.
# 75’, 100’ Ladders and 50’ Water Towers

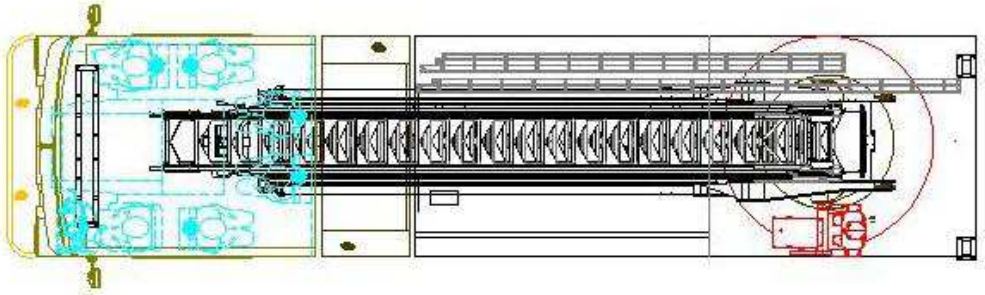
February 2015

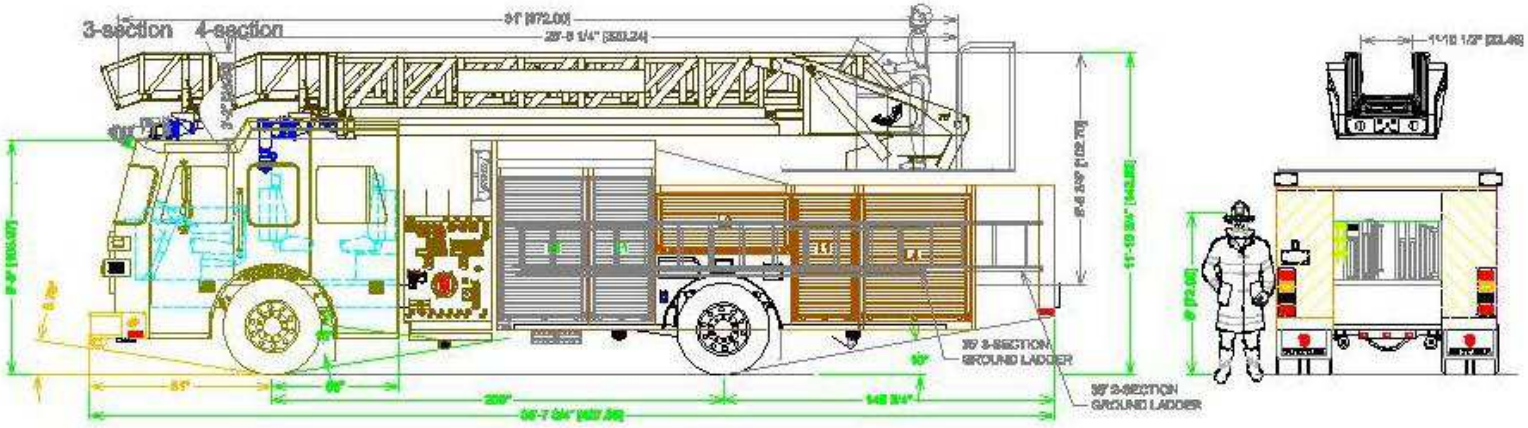
CONCEPT ONLY

| COMPT | DIMENSIONS |
|---|---|
| | |
| | |
| | |
| R1 | |
| R2 | |
| R3 | |
| R4 | |
| A1 | |

2 openings of 300 at 1 3/4" each
400 gallon tank



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DATE:

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DRAWN BY: XXX

DATE: YYYYMMDD

LAST REVISION: HILLIARD

SUTPHEN

FIRE DEPARTMENT
CITY, STATE

VEHICLE MODEL

SALES REP:

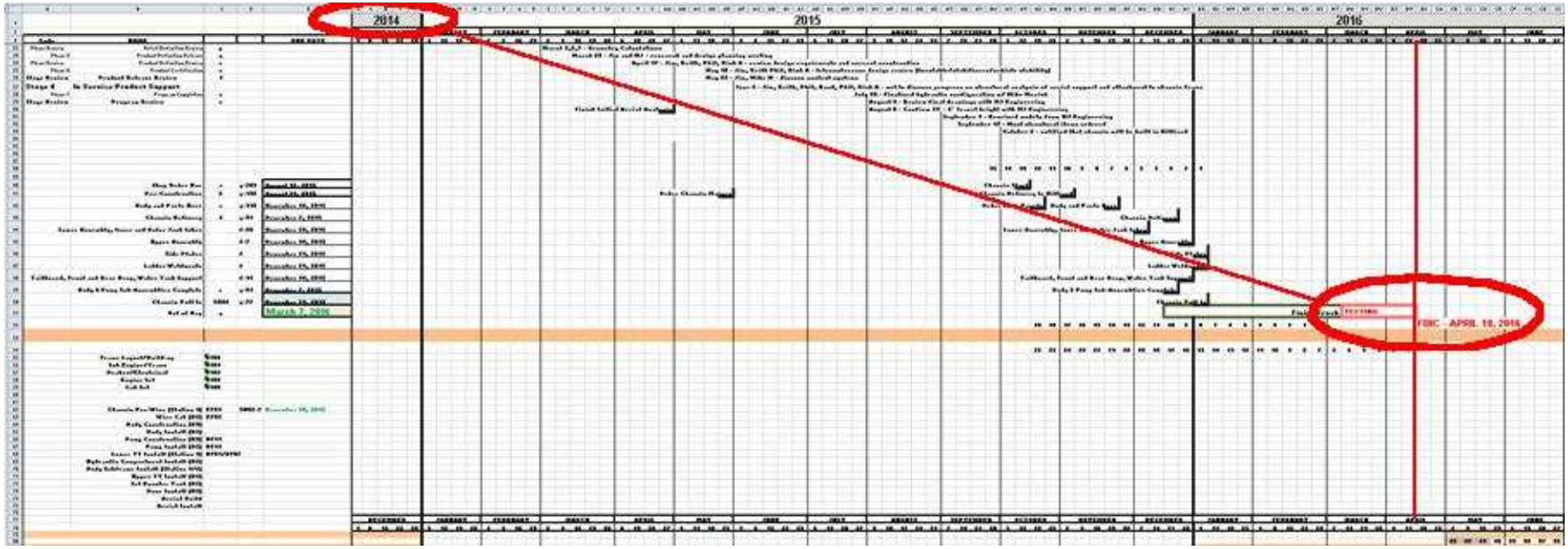

**Proof of Concept:** This is the primary aerial mounting orientation for ALL of our major competitors

**Completion Date:** Deliverable truck(s) by FDIC 2016 (April 18, 2016)

**Design Goals:** Design and build rear mounted aerial ladders and a water tower. What will we do with this design to distinguish our vehicle from our competitors (aside from the aerial)?

# Our Timeline

Development of the SLR75

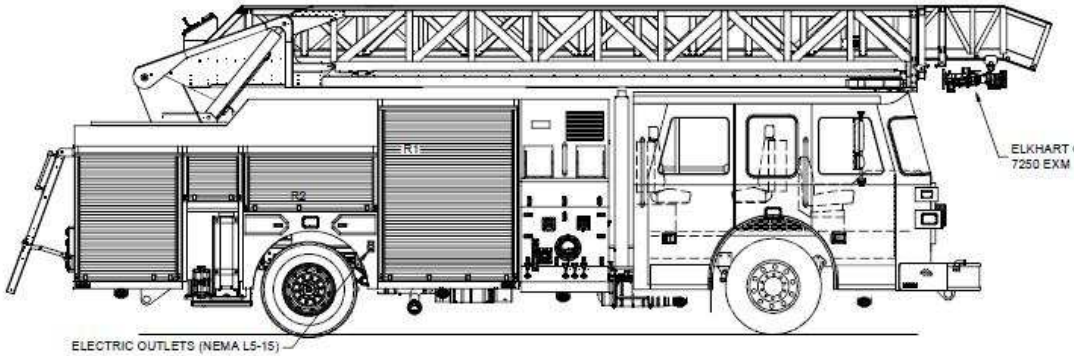


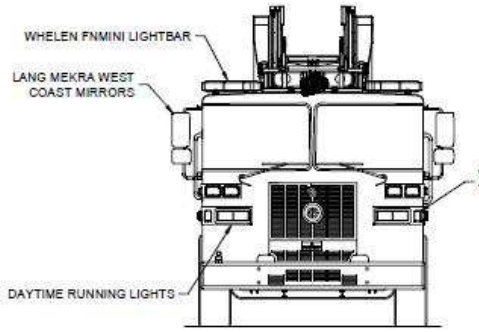
August 2015

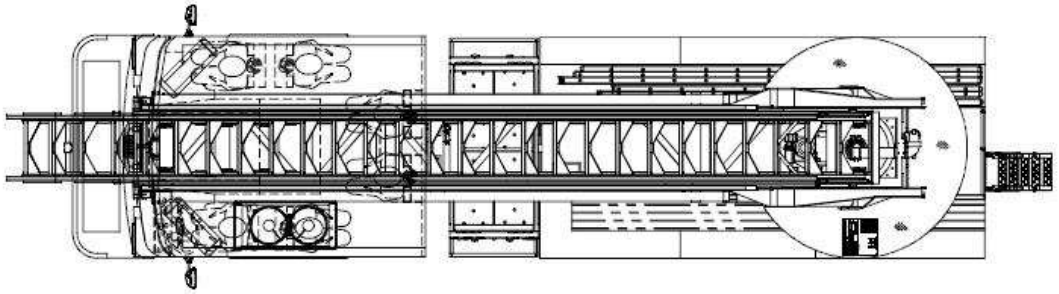
# Project Goals

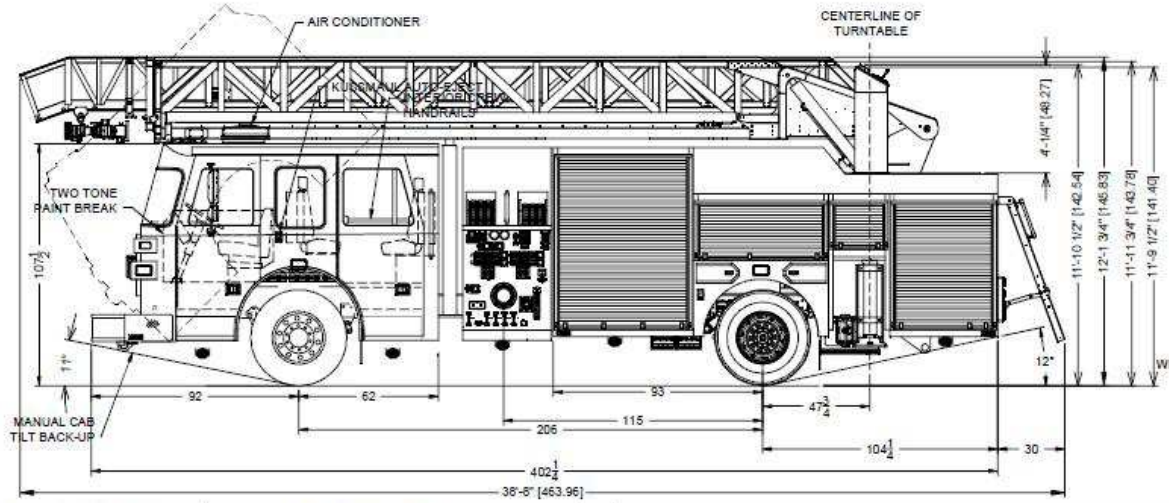
- Rear mounted 75’ aerial ladder
- Manual Aerial Controls
- Manual Jack Controls
- Out and Down stabilizers
- Price Conscience
- Ability to short jack
- 750 lb tip load (dry) – 3:1 safety factor
- Envelope control
- Travel height under 12’ – we are at 11’ -9” (on paper)
- 1000’ of 5” & 300’ of 3” hose and 500 gallons of water
- Storage for Stokes basket, backboard, Little Giant, fans

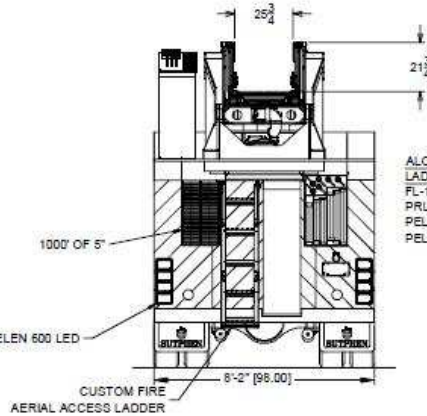
| Section | Max Tip Load Stress / FOS |
|---|---|
| First | 7.7 ksi / 4.7 |
| First (short) | 10.2 ksi / 3.5 |
| Second | 5.8 ksi / 6.2 |
| Second (short) | 7.0 ksi / 5.1 |
| Third | 7.4 ksi / 4.9 |
| Third (short) | 10.6 ksi / 3.1 |






ALCO-LITE QUINT
LADDER COMPLIMENT
FL-1 10' FOLDING
PRL-16 16' ROOF
PEL-24 24' 2-SECTION
PEL-35 35' 3-SECTION

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DRAWN BY: APF

DATE: 7/30/2015

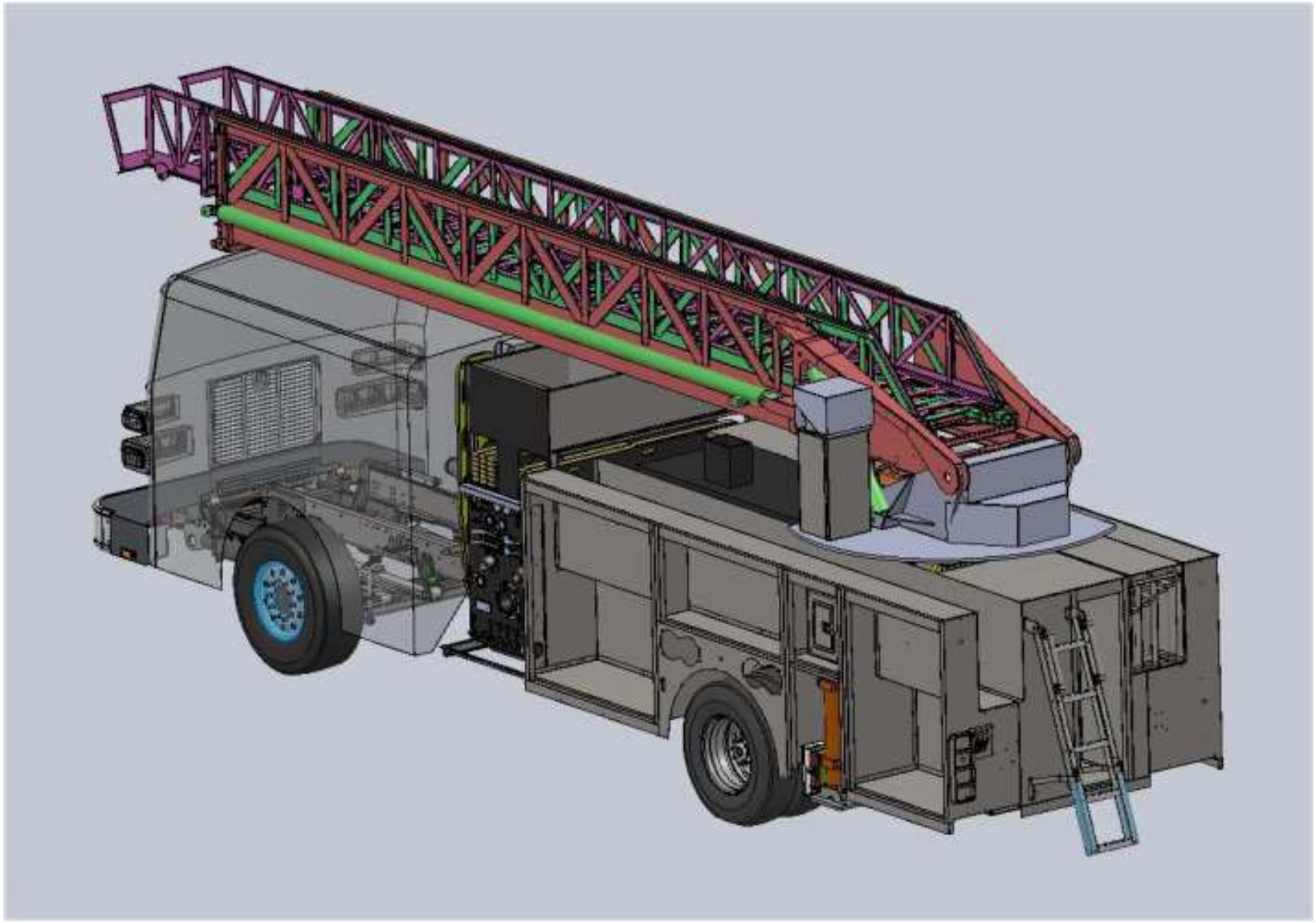
MFG FACILITY: HILLIARD

SUTPHEN
SUTPHEN
DEMO 404

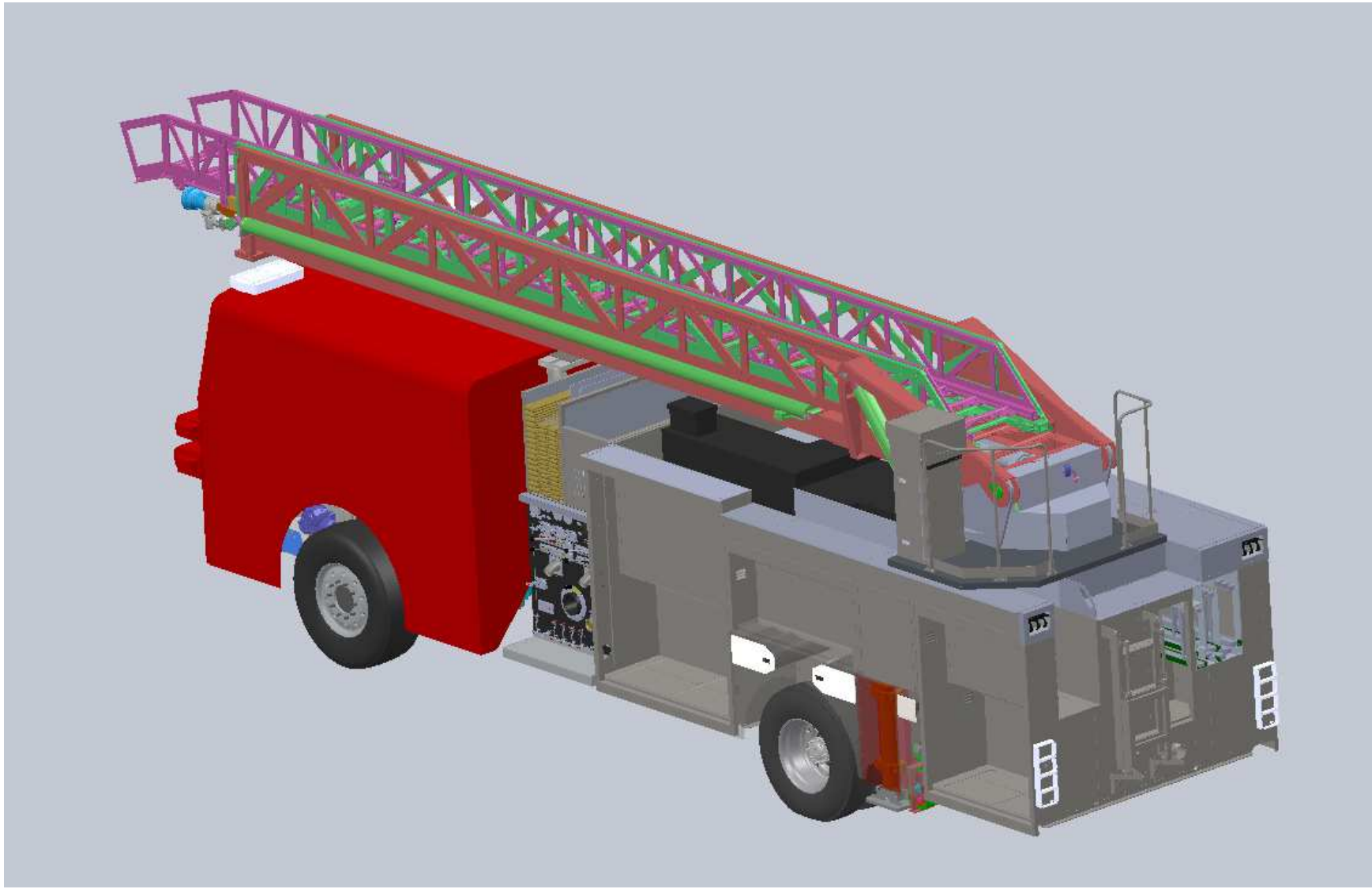
SLR75

ENG. NO: HS-5567

# Body Option 1

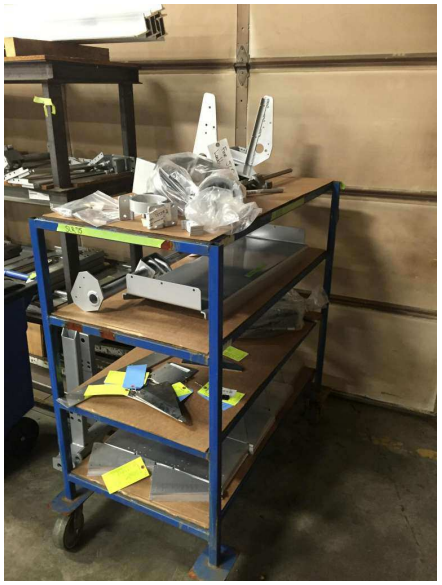


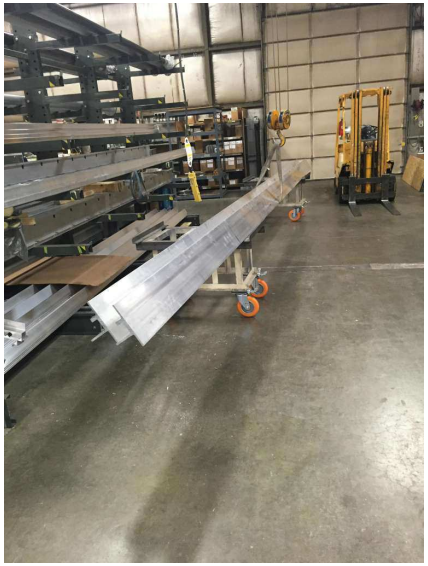
November 2015



# Aerial Support

# Aerial Device

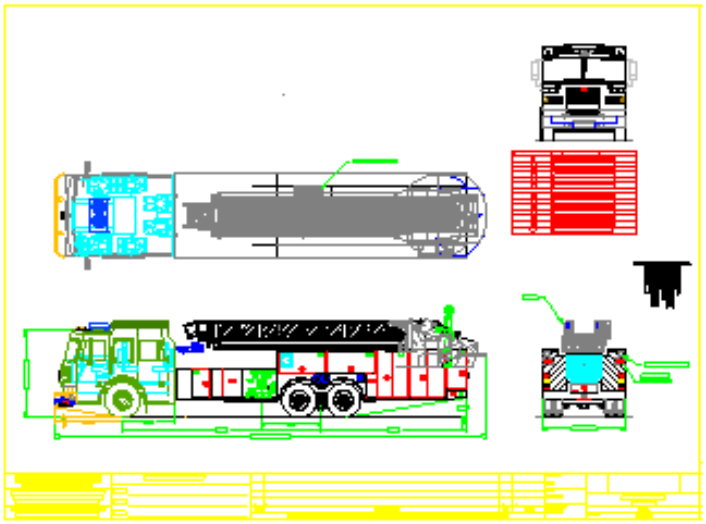


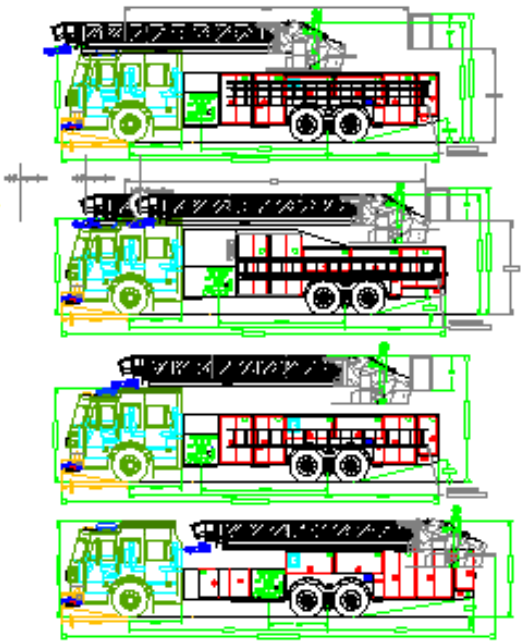


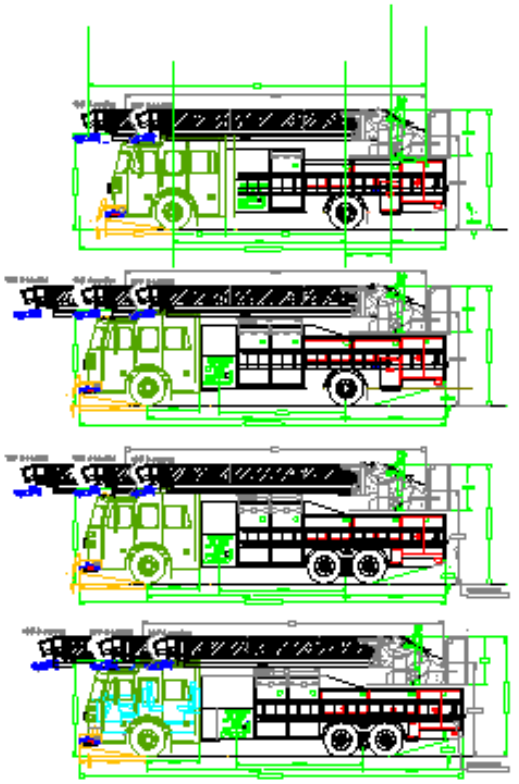

April 2016

# Center of Gravity (COG) Testing

May 2016







| | Sutphen | E1 | Pierce | | |
|---|---|---|---|---|---|
| | SLR108 | Metro 100 | Ascendant 107' | 105' | 100' |
| Aerial Construction | Hucked Aluminum | Welded Aluminum | 100ksi Steel | Steel | Aluminum |
| Vertical Reach | 108' | 100' | 107' | 105' | 100' |
| Horizontal Reach | | | 100' | | |
| Operating Range | | | -10° to +77° | +75° on midmount) | |
| Set-up Range | | | 6% level - up to 12% uphill slope | | |
| Number of Sections | 4 | 3/4? | 4 | | |
| Tip Load (w/out Water) | 750 lb | 300-825 lb (based on ladder position) | 750 lb + 100 lb eqpt (with restrictions) | 500 + 100 lb eqpt | 750 lb + 100 lb eqpt |
| Tip Load (w/ Water) | 500 lb | | 500 + 100 eqpt | | |
| Fly Section Width | | | 21.63" | | |
| Fly Section Height | | | 16.70" | | |
| Wind Load | 30 mph sustained | | 35 mph | 50 mph | |
| Ice Build-up | 1/4" | | 1/4" | 1/4" | |
| Waterway Flow | | | 1500 gpm | 1000 gpm | up to 1500 gpm |
| Safety Factors | | | | | |
| Aerial Structure | 3.0:1 | 2.5:1 | 2.0:1 | 2.5:1 | |
| Overturning | 1.5:1 | | 1.5 : 1 | | |
| Stabilizers | | | | | |
| Number of Stabilizers | 4 | 4 | 3 | 4 | 4 |
| Span of Stabilizers | 16' | 11' | 18' (13' short-jacked) | 14' | 12' (10' short-jacked) |
| | | | | | |
| Travel Height (with pre-plumbed w/w) | 11' - 9" | 10' - 10" | 11' - 5" (drawing shows 11' - 8") | | |
| Travel Length | | 38' - 6" | 39' - 2" | | |
| Estimated In Service Weight | | | | | |
| Number of Drive Axles | 1 | 1 | 1 | 2 | 2 |
| Wheelbase (base configuration) | 220" | 220" | 234" | | |
| Booster Tank Capacity | up to 500 gallons | | up to 500 gallons | | up to 500 gallons |
| Hose Storage | | | | | |
| Ground Ladders | | | | | |
| Turntable width | | | | 100" | |

# More Math (yuck, you say)

| SLR108 Stability | | PAS 2016.05.25 | | These are crude estimates |
|---|---|---|---|---|
| 8600 | lbf | Loaded platform ladder weight | | |
| 45500 | lbf | truck weight, empty and ignoring ladder | | |
| 137.0 | in | distance from truck cg to turntable axis | | |
| 472.1 | in | distance from turntable axis to ladder cg | | |
| 54100 | lbf | total weight | | |

| | Positions Relative to Turntable Axis | | | |
|---|---|---|---|---|
| rotation angle | ladder cgx | ladder cgz | total cgx | total cgy |
| 0 | 472.1 | 0.0 | 190.3 | 0.0 |
| 10 | 464.9 | 82.0 | 189.2 | 13.0 |
| 20 | 443.6 | 161.5 | 185.8 | 25.7 |
| 30 | 408.8 | 236.0 | 180.2 | 37.5 |
| 40 | 361.6 | 303.4 | 172.7 | 48.2 |
| 50 | 303.4 | 361.6 | 163.5 | 57.5 |
| 60 | 236.0 | 408.8 | 152.8 | 65.0 |
| 70 | 161.5 | 443.6 | 140.9 | 70.5 |
| 80 | 82.0 | 464.9 | 128.3 | 73.9 |
| 90 | 0.0 | 472.1 | 115.2 | 75.0 |
| 100 | -82.0 | 464.9 | 102.2 | 73.9 |
| 110 | -161.5 | 443.6 | 89.6 | 70.5 |
| 120 | -236.0 | 408.8 | 77.7 | 65.0 |
| 130 | -303.4 | 361.6 | 67.0 | 57.5 |
| 140 | -361.6 | 303.4 | 57.8 | 48.2 |
| 150 | -408.8 | 236.0 | 50.3 | 37.5 |
| 160 | -443.6 | 161.5 | 44.7 | 25.7 |
| 170 | -464.9 | 82.0 | 41.3 | 13.0 |
| 180 | -472.1 | 0.0 | 40.2 | 0.0 |

Radius of the stability circle

Center of the stability circle, relative to the turntable axis

Note that for different loads, the center of the circle doesn't change much

| Ladder Parameters | | | |
|---|---|---|---|
| Unloaded | Mass | 7850 | Jim, the unloaded values are my |
| | CG | 404 | estimates from CAD and scaling the |
| Tip Load | Mass | 750 | SLR75 ladder |
| | CG | 1184.5 | Enter any value in the tip load box |

Real rough numbers used for this truck

| | | |
|---|---|---|
| Front axle empty | 18000 | |
| Rear axle empty | 27500 | |
| cgx position wrt front axle | 0.60 | |
| as fraction of wheelbase | | |
| SLR108 wheelbase | 220 | in |
| cgx estimate | 132.97 | in, wrt front axle |

SLR108 truck weight estimate

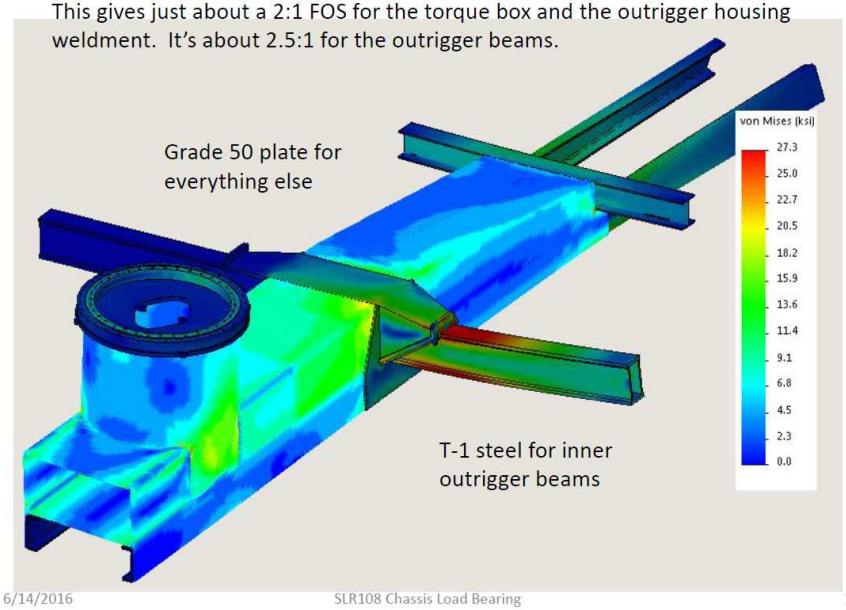
45500 lbf

Ignore ladder's effect on cgx

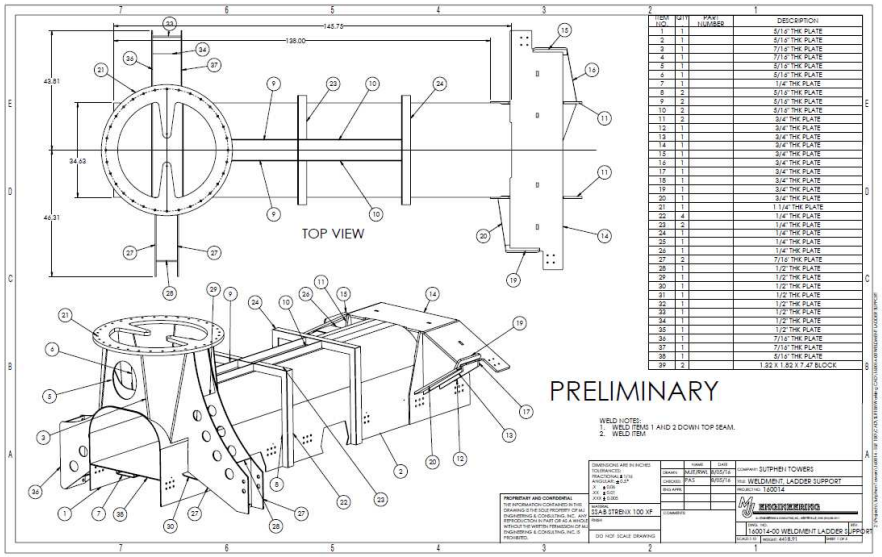
distance from rear axle to turntable 50 in

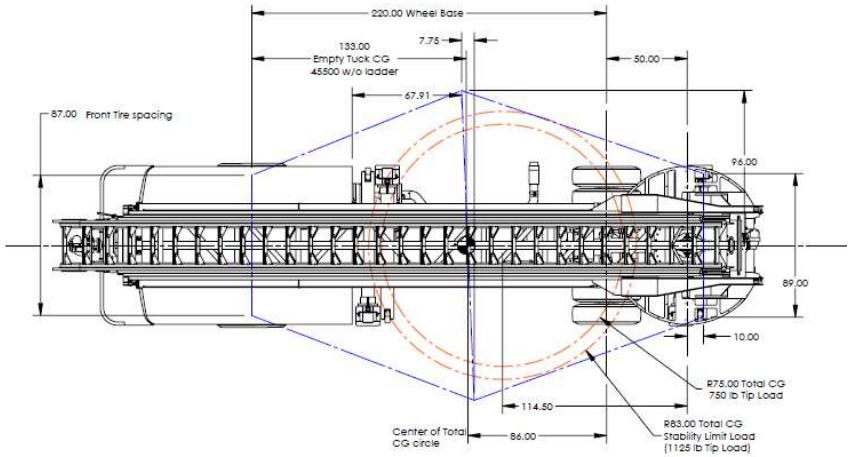
# Yes, we need a torque tube.

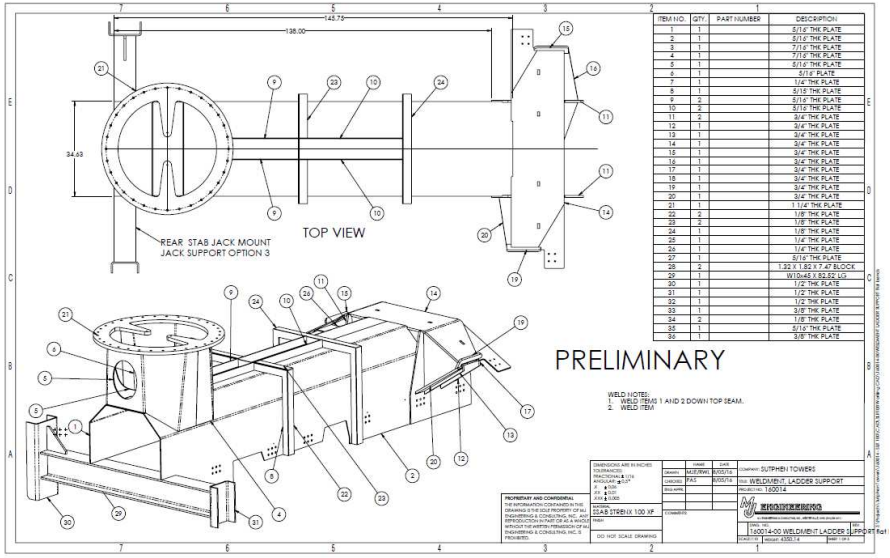
Torque box Design-Stress results for Ladder off side, full extend, 750 tip load. This gives just about a 2:1 FOS for the torque box and the outrigger housing weldment. It's about 2.5:1 for the outrigger beams.



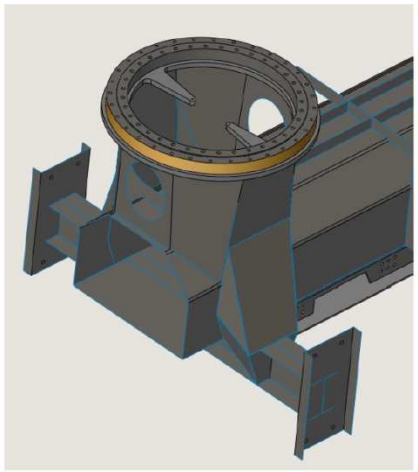


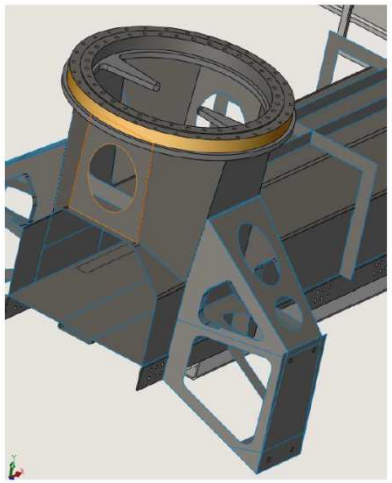



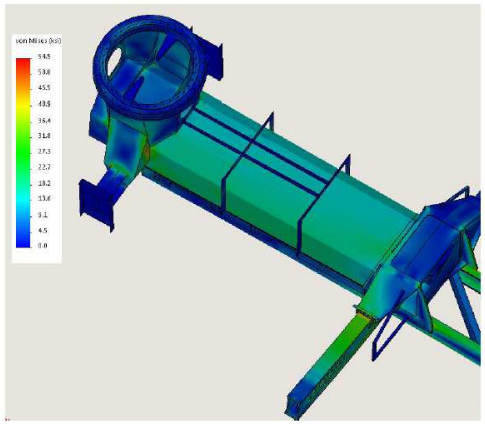
Beam Style



Wing Style



Beam Style



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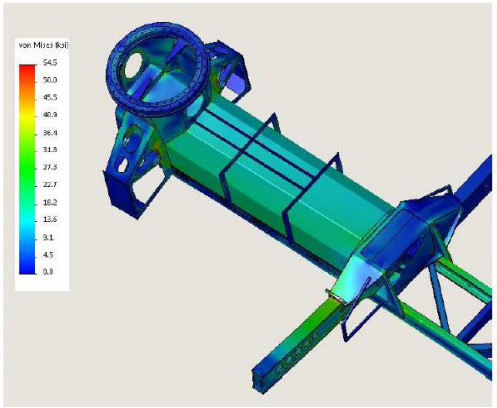

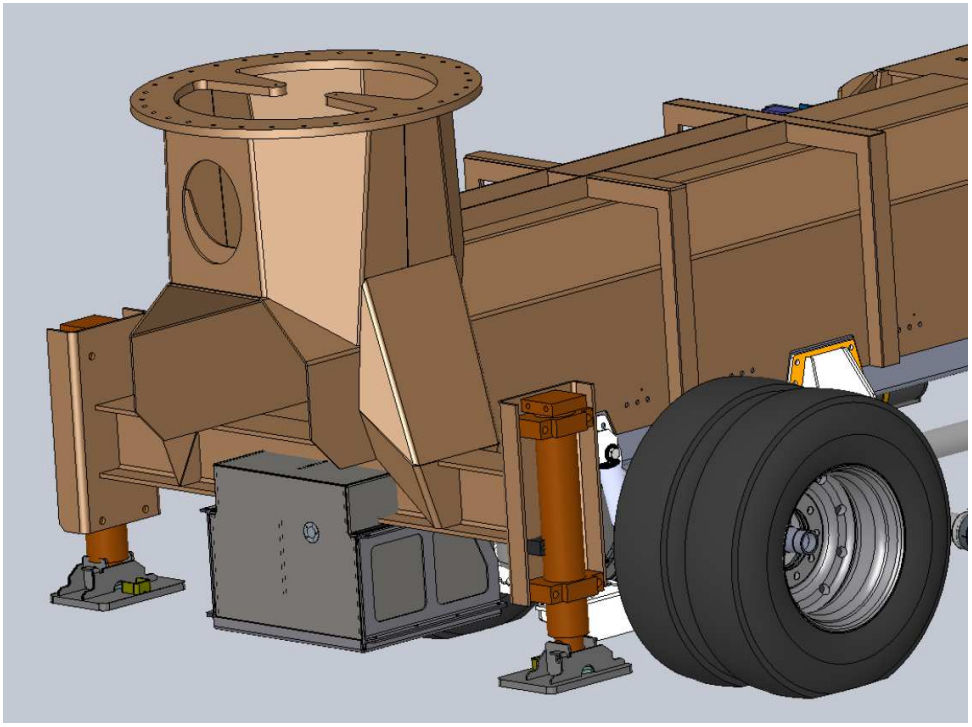

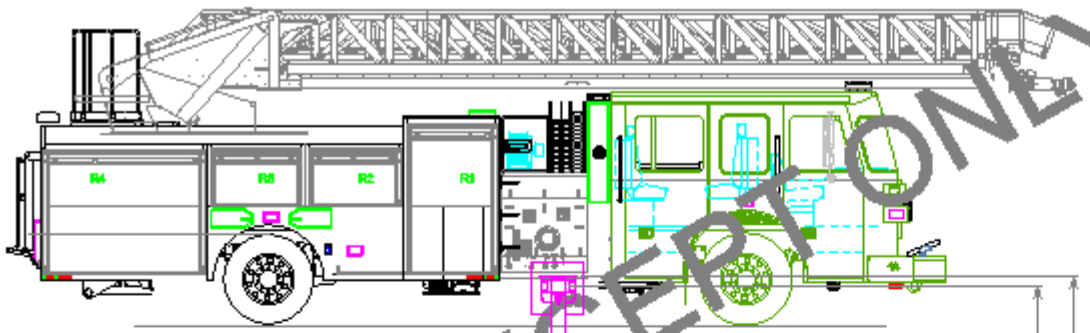


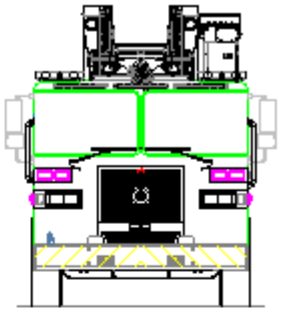

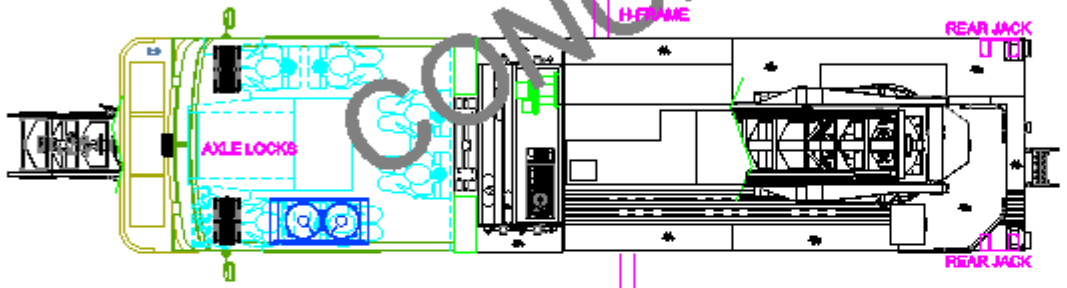


| ITEM | QTY | SPECIFICATION | MANUFACTURER | VALUE |
|---|---|---|---|---|
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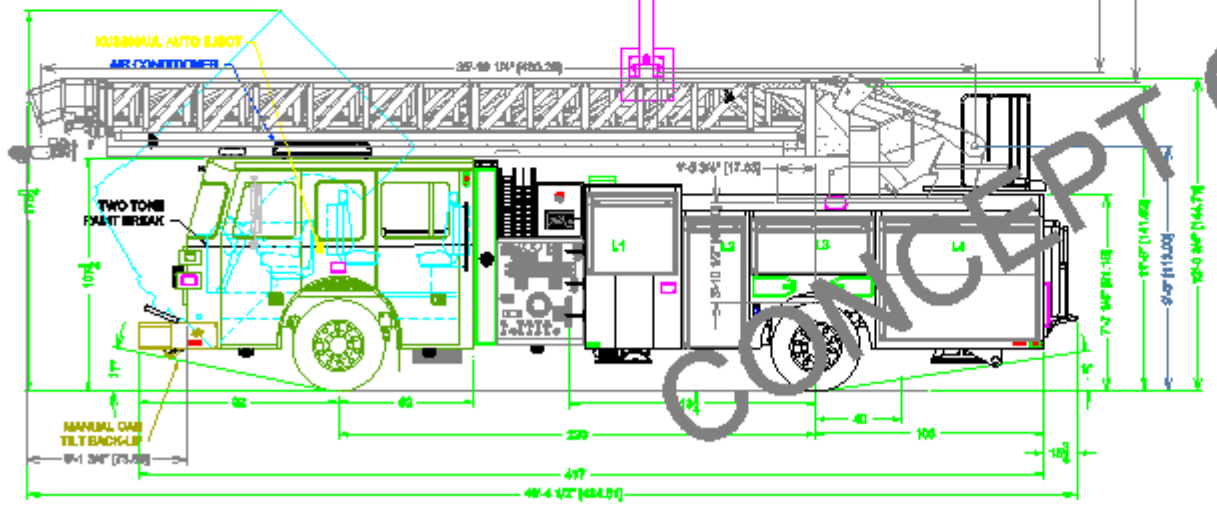


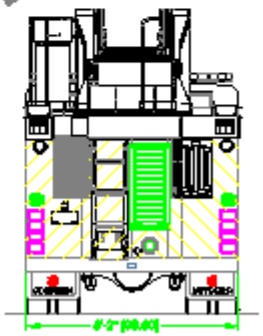

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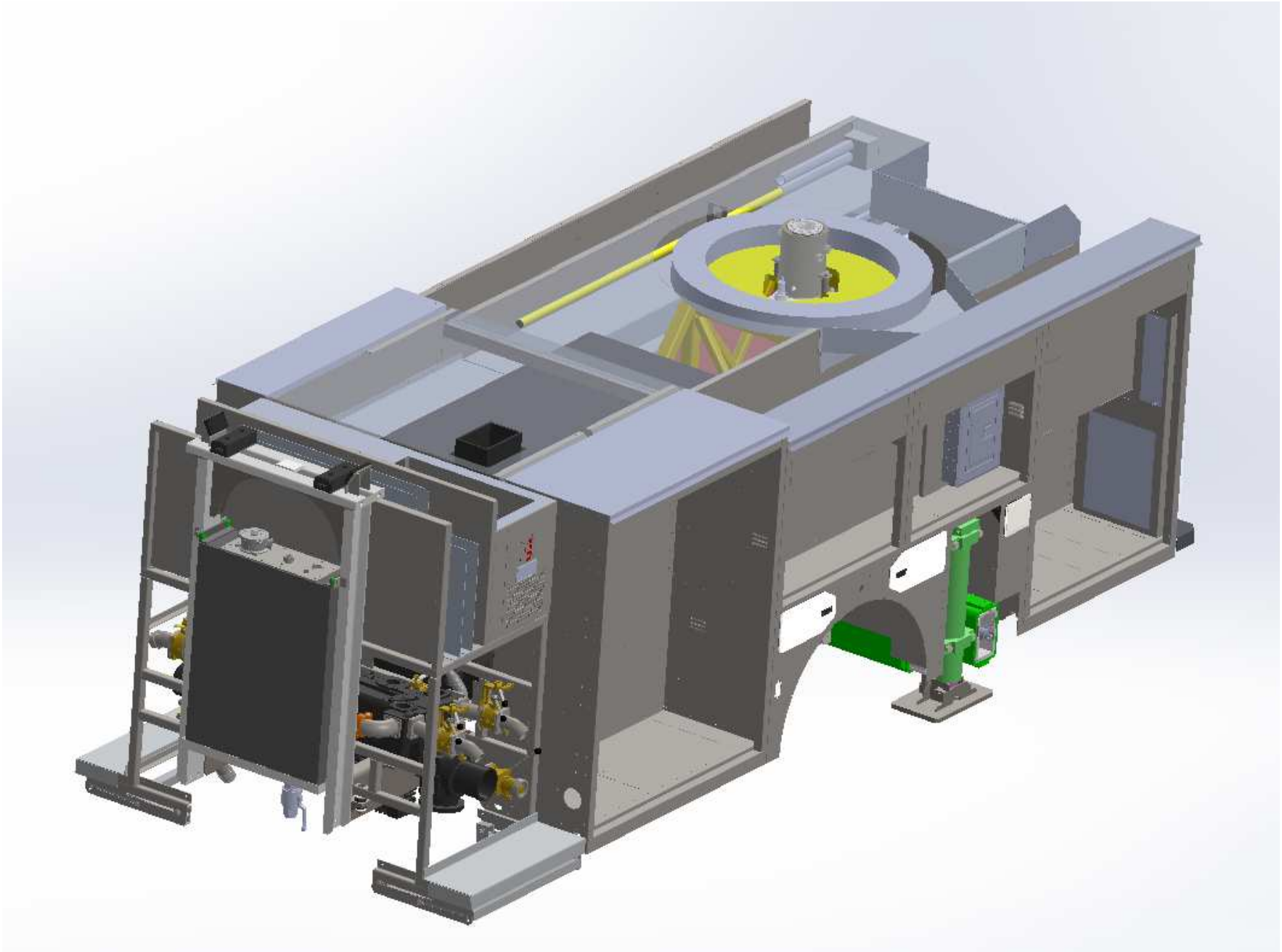
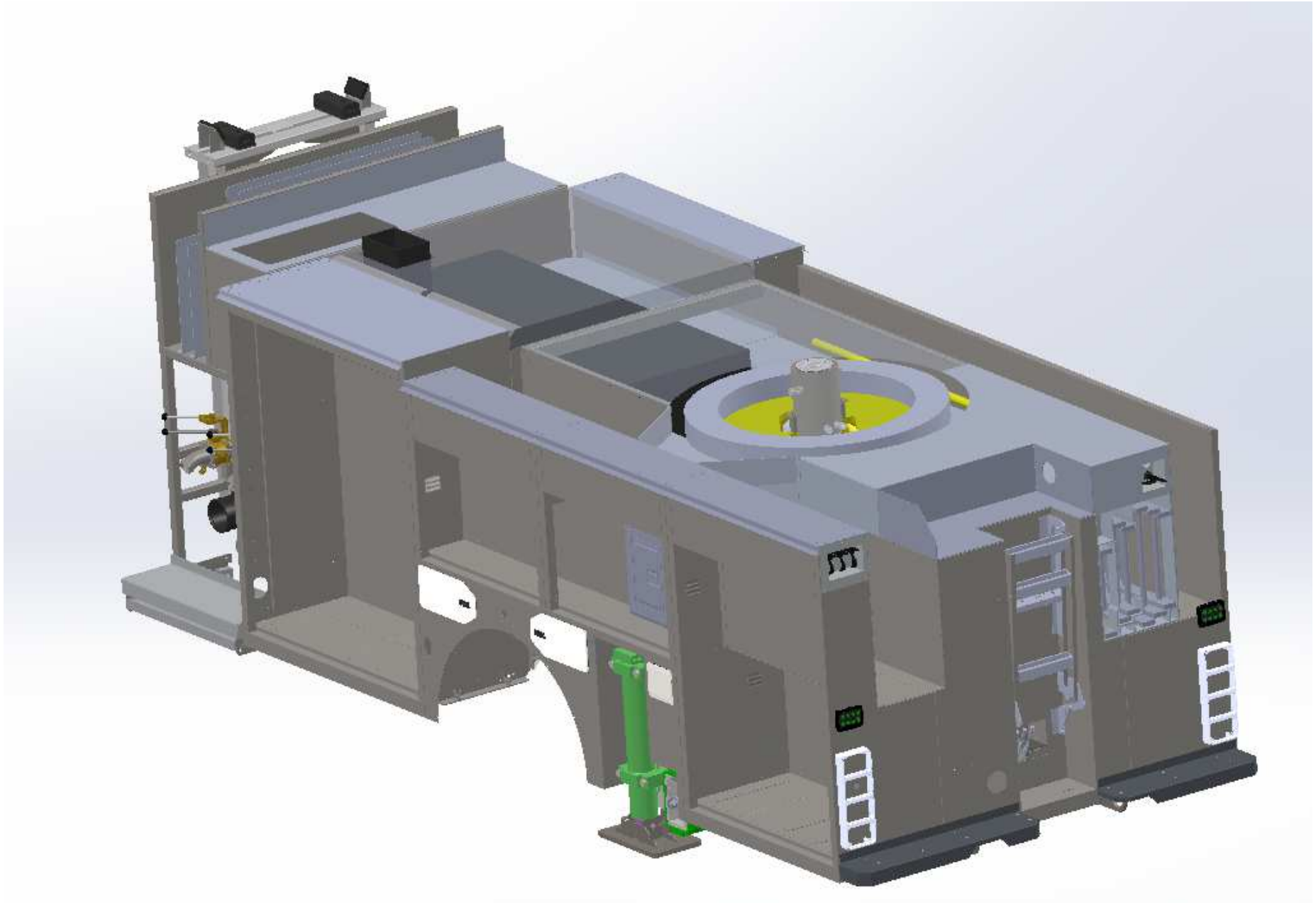
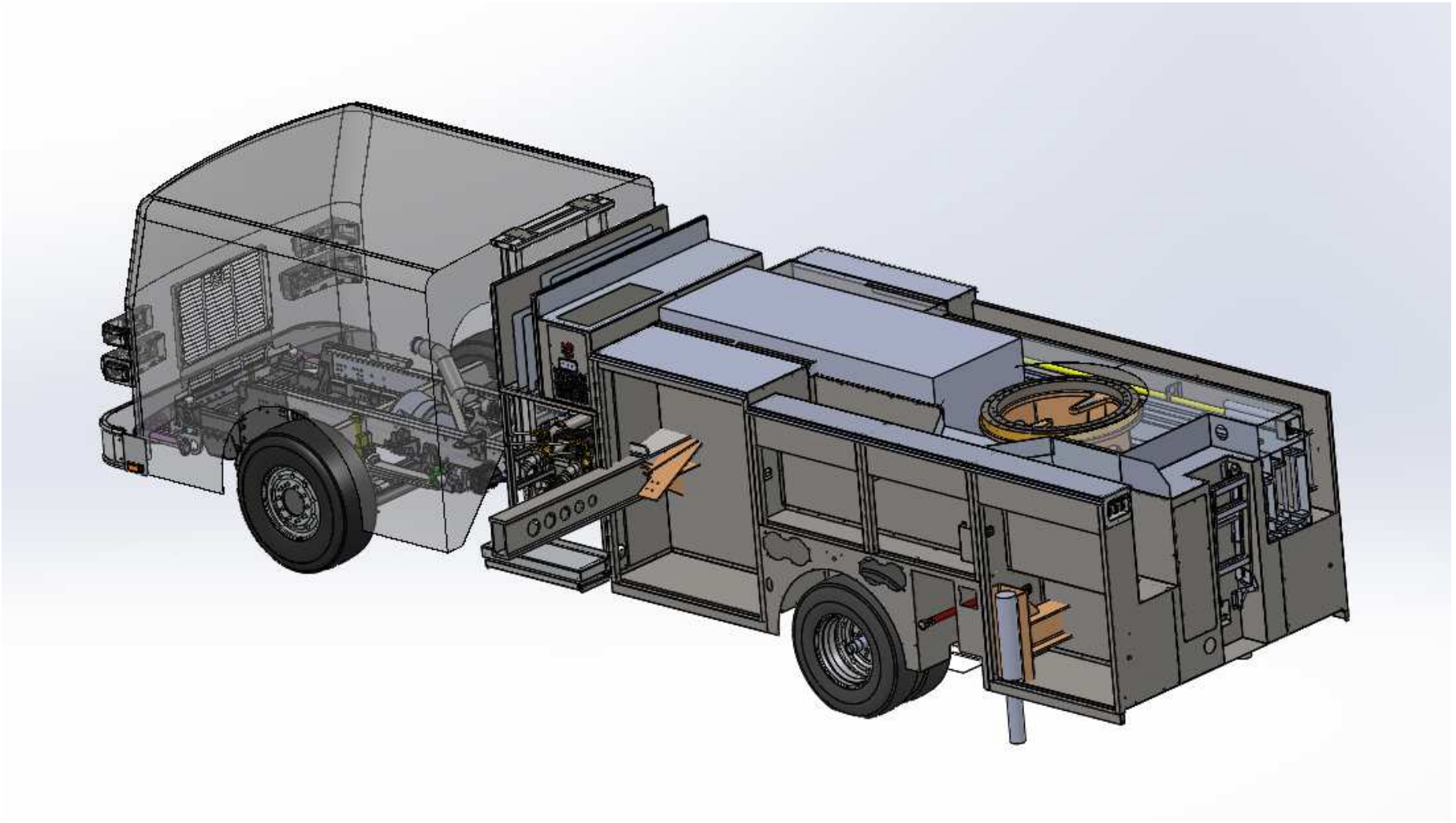
| | DATE: | REV. | DESCRIPTION | BY | DATE | | |

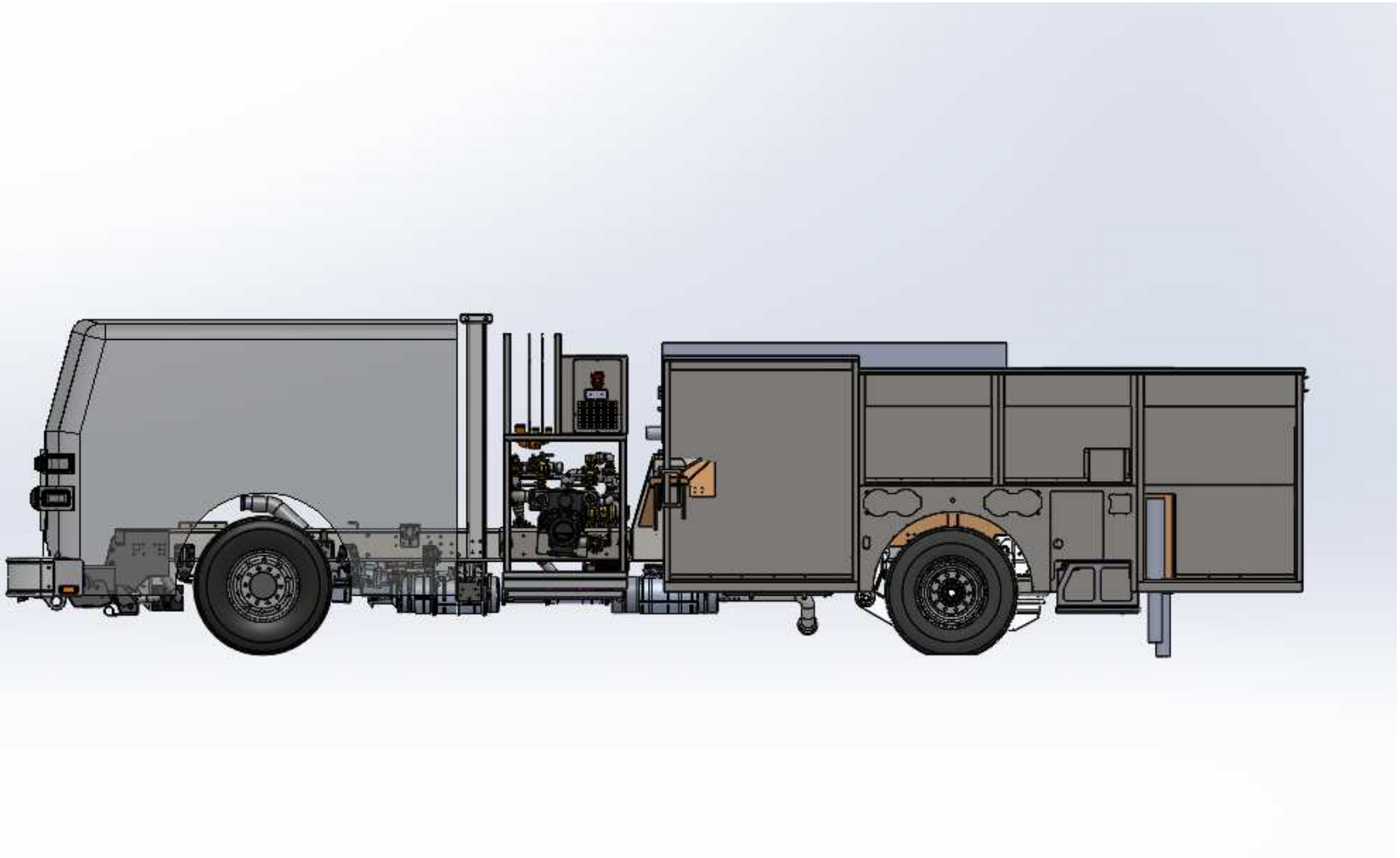
August 2016

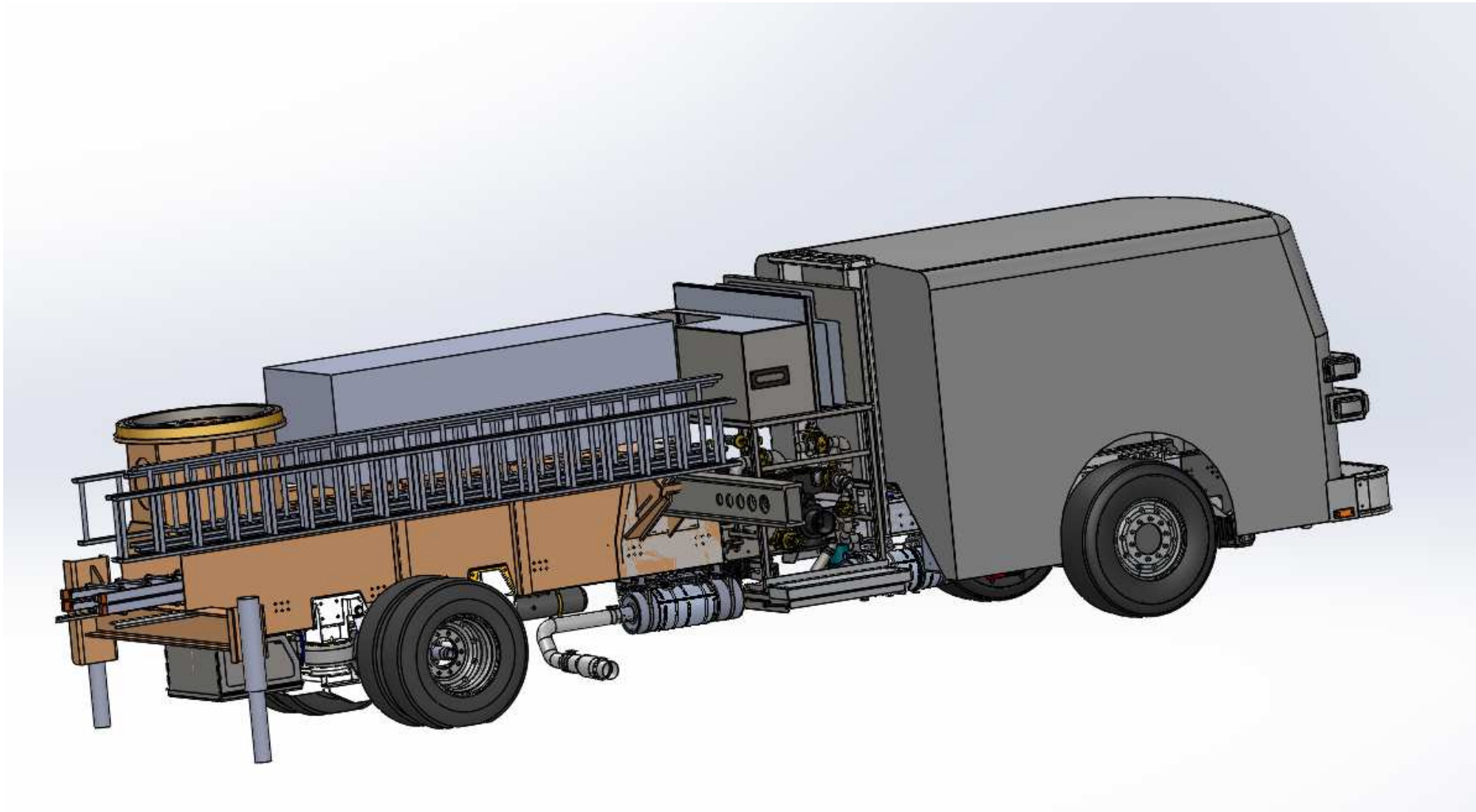


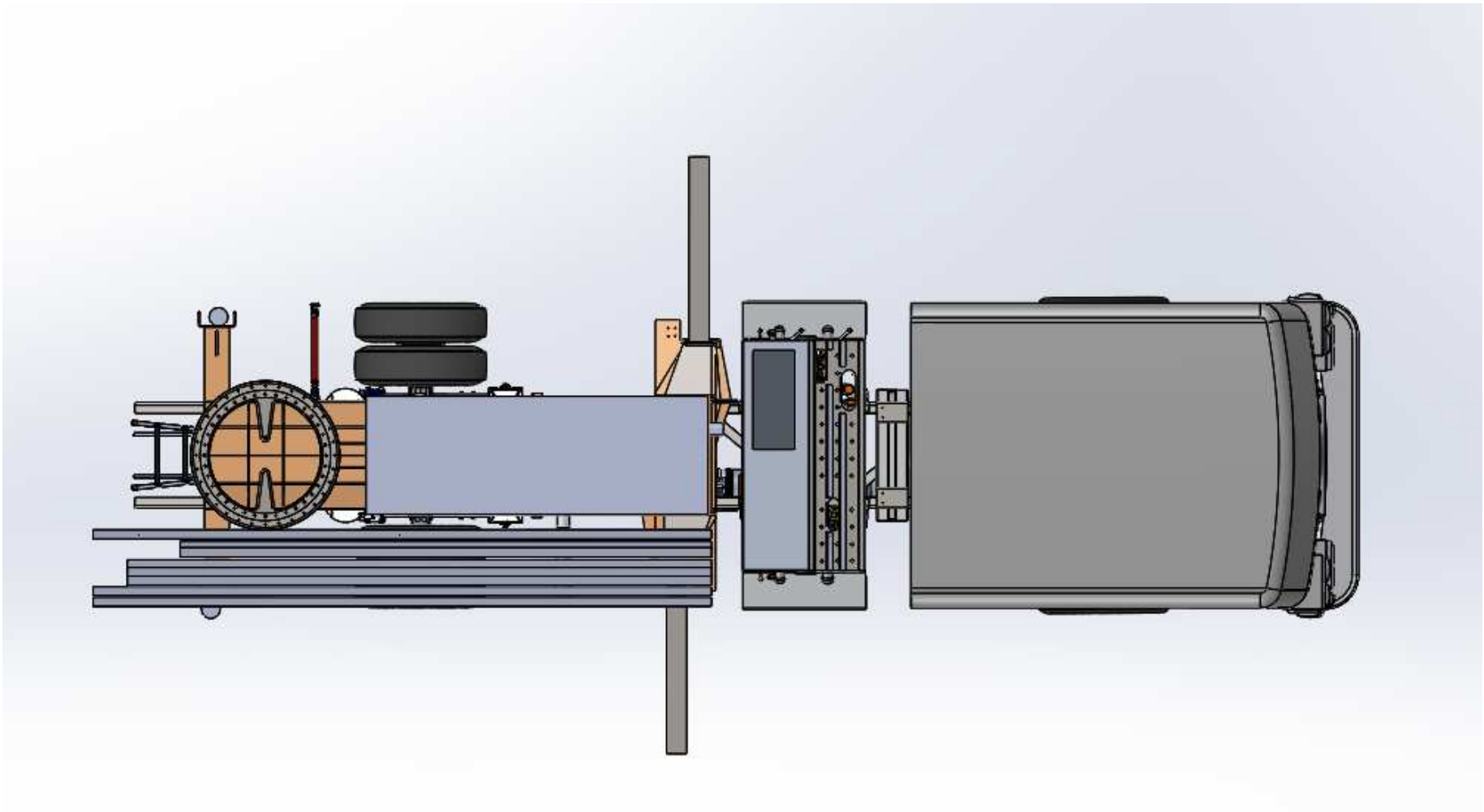


September 2016
Where are we today?









# Where do we go from here?


# SUTPHEN

**Beyond!**



Thank You!