

ETHANE INJECTION AT THE REDWING CREEK FIELD NORTH DAKOTA

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**USING WHAT YOU HAVE TO GET WHAT YOU NEED
WHEN YOU'RE CAUGHT BETWEEN SPECIFICATIONS**

SALES GAS LIMITS

1210 BTU/FT³

**HYDROCARBON DUE POINT LESS THAN 5 °F @ 800 psig
LESS THAN 7 lbs./MMSCFD WATER CONTENT**

INLET GAS STREAMS

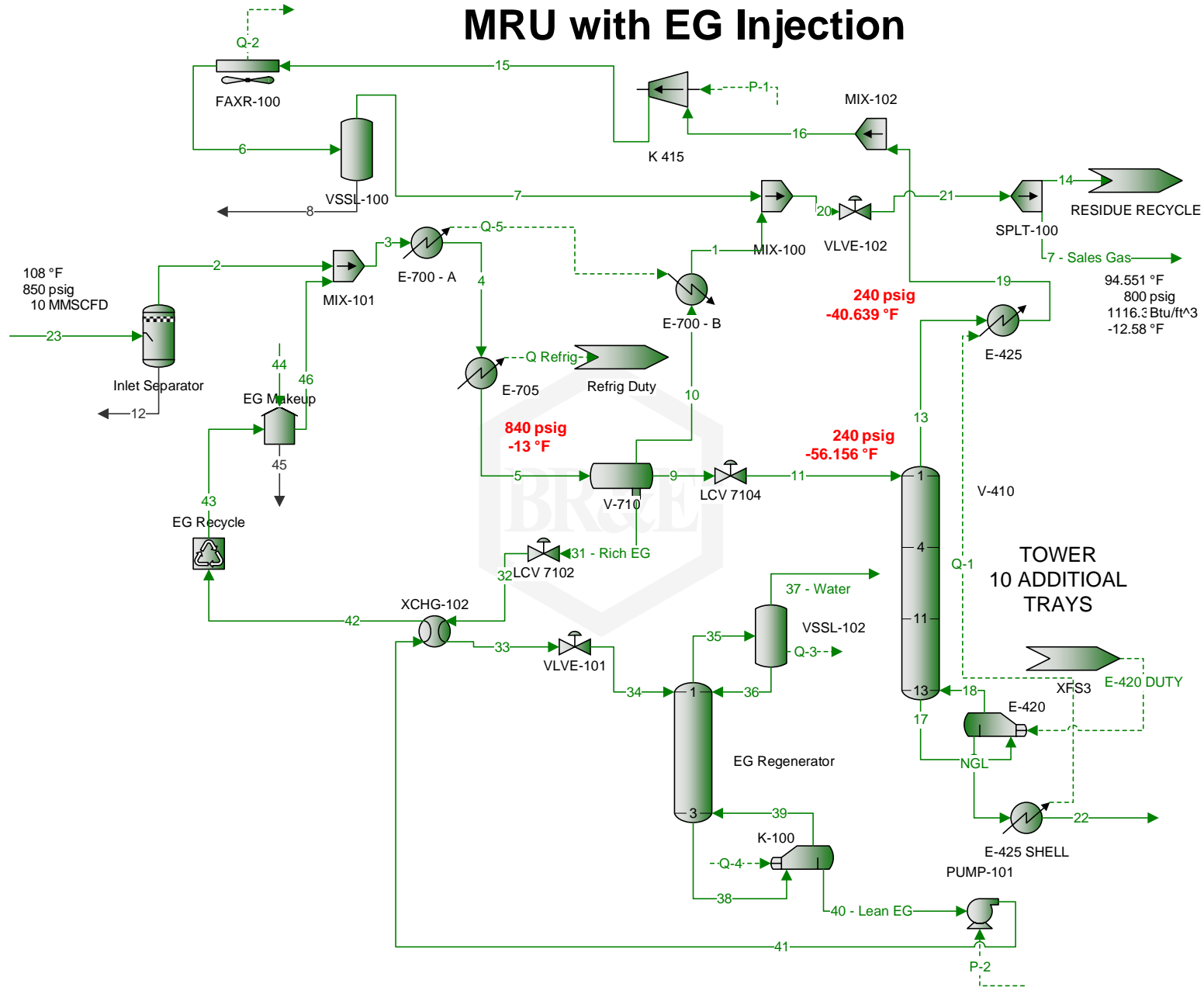
| Names | Units | Res'vior Gas 2017 | THIRD PARTY GAS |
|-------------------------------|---------------------|-------------------|-----------------|
| Std Vapor Volumetric Flow | MMSCFD | 3.296 | 3.139* |
| Gross Ideal Gas Heating Value | Btu/ft ³ | 1342.5 | 1510.2 |
| Nitrogen(Mole Fraction) | % | 8.53 | 2.1179 |
| Carbon Dioxide(Mole Fraction) | % | 0.63 | 0.64932 |
| Methane(Mole Fraction) | % | 59.71 | 56.742 |
| Ethane(Mole Fraction) | % | 15.71 | 20.094 |
| Propane(Mole Fraction) | % | 8.95 | 11.625 |
| i-Butane(Mole Fraction) | % | 1.09 | 1.4379 |
| n-Butane(Mole Fraction) | % | 3.02 | 4.1962 |
| i-Pentane(Mole Fraction) | % | 0.68 | 0.8242 |
| n-Pentane(Mole Fraction) | % | 0.91 | 1.1462 |
| n-Hexane(Mole Fraction) | % | 0.61 | 0.33064 |

TAKE ADVANTAGE OF COMMERCIAL PROPANE & BUTANE MARKETS

AVAILABLE THIRD PARTY Y-GRADE PRODUCT

| Names | Units | THIRD PARTY Y-GRADE |
|---|--------|---------------------|
| Std Liquid Volumetric Flow | bbbl/d | 1062.9* |
| Ethane(Std Liquid Volumetric Fraction) | % | 8.341* |
| Propane(Std Liquid Volumetric Fraction) | % | 39.993* |
| i-Butane(Std Liquid Volumetric Fraction) | % | 6.4814* |
| n-Butane(Std Liquid Volumetric Fraction) | % | 20.517* |
| i-Pentane(Std Liquid Volumetric Fraction) | % | 5.0182* |
| n-Pentane(Std Liquid Volumetric Fraction) | % | 7.5903* |
| n-Hexane(Std Liquid Volumetric Fraction) | % | 1.9178* |

MRU with EG Injection



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MODIFICATIONS TO THE EXISTING MRU

TOWER METALERGY AND STAGES

DEMETHANIZER OVERHEAD COMPRESSOR

ADDED SMALL EXCHANGER TO HEAT THE OVERHEAD VAPORS

REPLACED THE GAS CHILLER AND SOME PIPING

ABANDONED THE PROPANE PRODUCT CHILLER

ADDED SMALL EXCHANGER TO SUBCOOL THE PROPANE PRODUCT AND WARM THE NEW DEETHANIZER FEED

ROUTED DEMETHANIZER BOTTOM PRODUCT TO STORAGE

PIPING MODIFICATION TO THE REFRIGERANT CONDENSER

INSTALLING EXTENDED DEMETHANIZER



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NEW CHILLER INSTALLATION



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NEW CHILLER IN PLACE



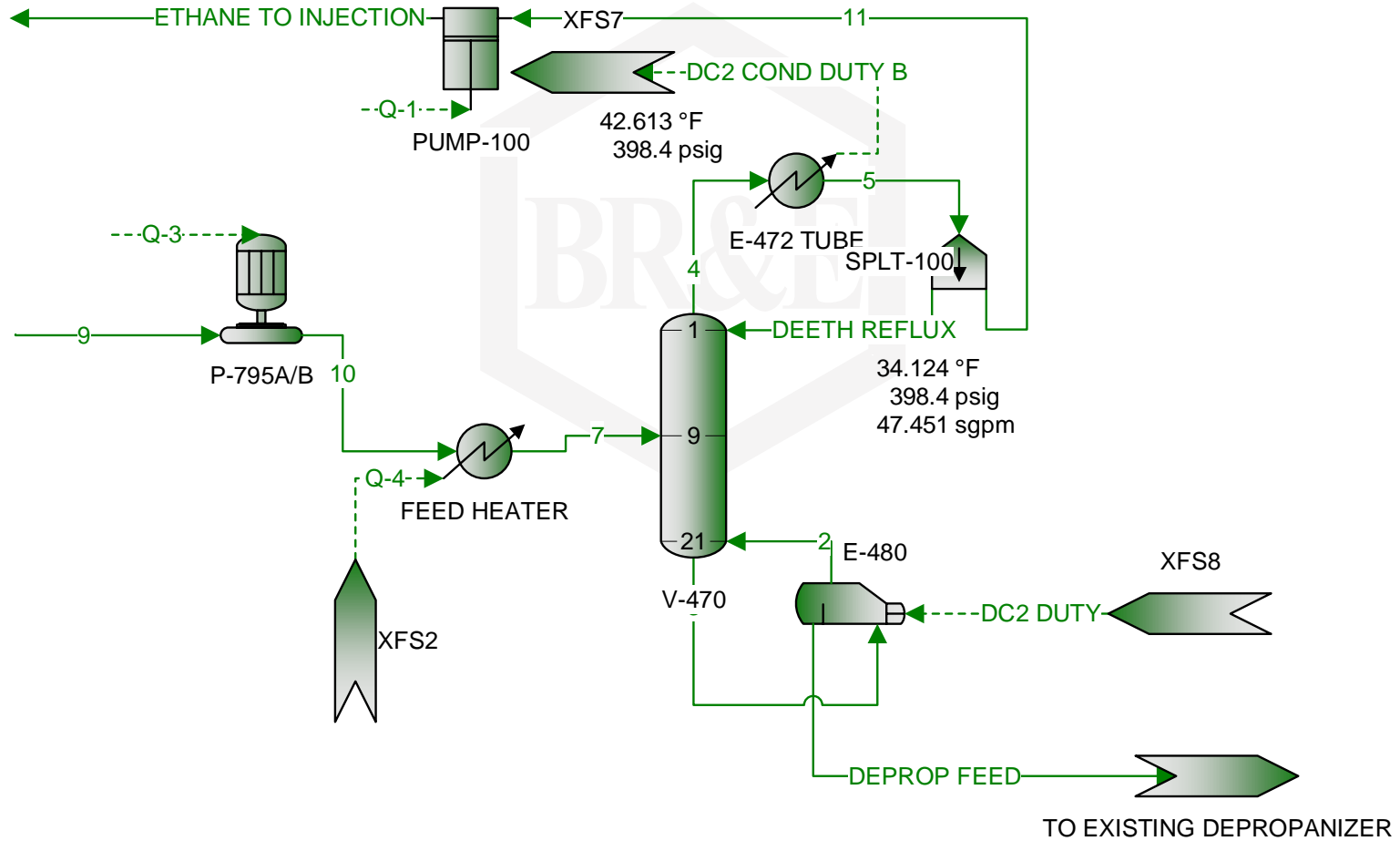
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NEW DEETHANIZER



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NEW DEETHANIZER

INSTALLED DEETHANIZER COLUMN

REUSE THE OLD GAS CHILLER AS THE NEW REFLUX CONDENSER

NEW REFLUX/BOOSTER PUMPS

INSTALLED NEW ETHANE INJECTION PUMPS

**PROVIDED OVERHEAD VAPOR FLOW CONTROL FOR SALES GAS BTU
OPTIMIZATION**

UPPER DEETHANIZER SKID



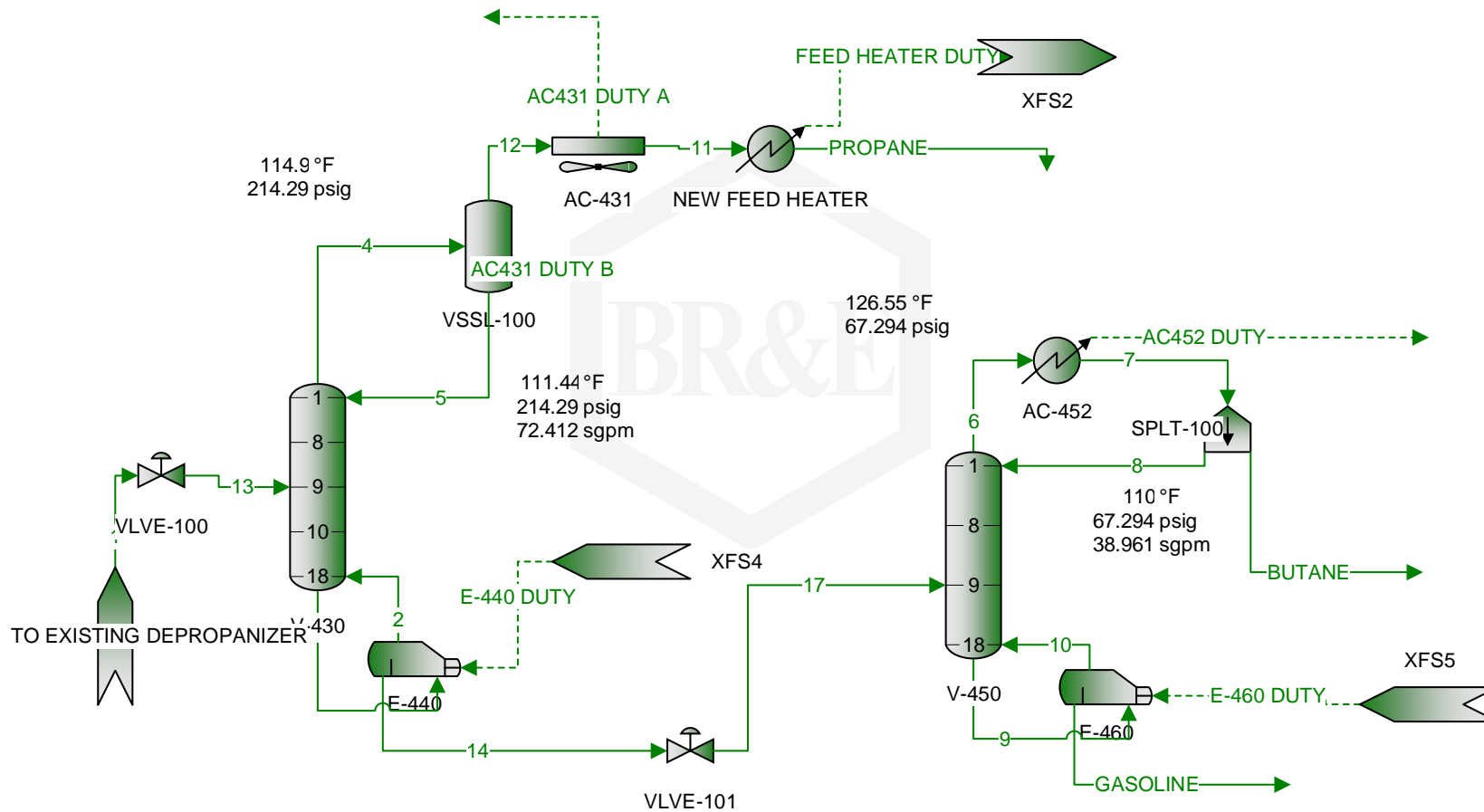
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EXISTING FRACTIONATION



INSIDE THE DEBUTANIZER



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DEBUTANIZER STRUCTURED PACKING



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INSTALLING THE DEBUTANIZER



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FRACTIONATED PRODUCTS

| Names | Units | DEPROP FEED | BUTANE | GASOLINE | PROPANE | ETHANE TO INJECTION |
|---|-------|-------------|------------|------------|------------|---------------------|
| Ethane(Std Liquid Volumetric Fraction) | % | 3.1526 | 3.9889e-05 | 0 | 6.5073 | 97.417 |
| Propane(Std Liquid Volumetric Fraction) | % | 45.037 | 1.9297 | 2.5418e-07 | 91.692 | 0.55669 |
| i-Butane(Std Liquid Volumetric Fraction) | % | 7.6971 | 21.917 | 0.0022611 | 1.467 | 0.00018334 |
| n-Butane(Std Liquid Volumetric Fraction) | % | 23.929 | 74.353 | 0.34822 | 0.333 | 0.00014675 |
| i-Pentane(Std Liquid Volumetric Fraction) | % | 5.8311 | 1.5443 | 27.129 | 0.00017157 | 1.128e-07 |
| n-Pentane(Std Liquid Volumetric Fraction) | % | 8.5375 | 0.25572 | 42.967 | 6.7485e-05 | 3.6222e-08 |
| n-Hexane(Std Liquid Volumetric Fraction) | % | 0 | 0 | 0 | 0 | 0 |
| nC7(Std Liquid Volumetric Fraction) | % | 0 | 0 | 0 | 0 | 0 |
| nC8(Std Liquid Volumetric Fraction) | % | 0 | 0 | 0 | 0 | 0 |
| nC9(Std Liquid Volumetric Fraction) | % | 0 | 0 | 0 | 0 | 0 |
| nC10(Std Liquid Volumetric Fraction) | % | 0 | 0 | 0 | 0 | 0 |
| True Vapor Pressure | psig | | 44.137 | 0.28354 | 203.94 | |
| Std Liquid Volumetric Flow | bbl/d | 1908.3 | 608.26 | 375.56 | 924.52 | 464.55 |
| Std Liquid Volumetric Flow | sgpm | 55.66 | 17.741 | 10.954 | 26.965 | 13.549 |

WHAT GOES AROUND COMES AROUND

**INCREASING ETHANE IN FUTURE RESERVIOR GAS
COMPOSITIONS**

EVENTUAL MODIFCATIONS MAY BE REQUIRED

RESERVIOR GAS OVER TIME

| Names | Units | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 | 2030 |
|-------------------------------|---------------------|--------|--------|--------|---------|---------|---------|---------|
| Std Vapor Volumetric Flow | MMSCFD | 3.296 | 2.927 | 2.904 | 2.862 | 2.845 | 2.778 | 1.25 |
| Gross Ideal Gas Heating Value | Btu/ft ³ | 1342.5 | 1354.1 | 1384.5 | 1411.4 | 1424.1 | 1431.3 | 1541.1 |
| Nitrogen(Mole Fraction) | % | 8.53 | 8.32 | 7.73 | 7.1814 | 6.8693 | 6.6687 | 4.5801 |
| Carbon Dioxide(Mole Fraction) | % | 0.63 | 0.64 | 0.67 | 0.69014 | 0.70993 | 0.71986 | 0.81003 |
| Methane(Mole Fraction) | % | 59.71 | 58.66 | 55.23 | 51.88 | 49.905 | 48.73 | 34.711 |
| Ethane(Mole Fraction) | % | 15.71 | 16.86 | 21.37 | 25.965 | 28.907 | 30.724 | 49.632 |
| Propane(Mole Fraction) | % | 8.95 | 9.03 | 8.69 | 8.2216 | 7.7992 | 7.5285 | 5.6902 |
| i-Butane(Mole Fraction) | % | 1.09 | 1.1 | 1.06 | 1.0102 | 0.9599 | 0.92981 | 0.72852 |
| n-Butane(Mole Fraction) | % | 3.02 | 3.03 | 2.93 | 2.8006 | 2.6697 | 2.5795 | 2.0145 |
| i-Pentane(Mole Fraction) | % | 0.68 | 0.69 | 0.68 | 0.66013 | 0.62994 | 0.60988 | 0.52302 |
| n-Pentane(Mole Fraction) | % | 0.91 | 0.92 | 0.9 | 0.87017 | 0.83992 | 0.80984 | 0.69722 |
| n-Hexane(Mole Fraction) | % | 0.61 | 0.62 | 0.61 | 0.59012 | 0.56994 | 0.54989 | 0.46331 |

FOR MY FELLOW TEXANS, PORTA POTTY @ -27°F



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