



# PLUG-IN-HYBRID-ELECTRIC POLAR TRAVERSE VEHICLE #1 (PHE-PTV) SPECIFICATIONS

(Integration Period February, 2009 – October, 2014)



DESIGNATION "TUESDAY"

### WEIGHTS AND DIMENSIONS

Curb Weight	9,400 lbs tires / 11,320 lbs tracks
Payload	TBD lbs
Gross Vehicle Weight	TBD lbs
Length	207 in tires / 216 in tracks
Width (w/mirrors folded)	86 in tires / 102 in tracks
Height	91 in tires / 101 in tracks
Wheelbase	130 in
Ground Clearance	20 in tires / 24 in tracks

### PERFORMANCE (w/radial tires & GVW of TBD lbs.)

0 - 60 mph (tires)	7.2 sec*
Maximum Speed	93 mph*
Maximum Speed with Mattracks	45mph*
Gradeability	60%*
Range (tires/tracks)	
Hybrid mode	628 miles tires*/tracks TBD
Electric/Clean Air(TM) mode	32 miles tires*/tracks TBD

### ELECTRIC DRIVE MOTORS

Supplier	UQM Technologies
Type	PowerPhase 150, Brushless Permanent Magnet
Number	2
Total Shaft Hp	200 Hp
Total Stalled Wheel Torque	650 N·m
Coolant (# gallons)	Propylene Glycol, TBD gal
Pinion Coupling	K&N Engineering, DRS, Love Joy, BigDog

### SUSPENSION

Independent Double A-Frame	AM General
12,100 GVW Coil Springs and Hydraulic Shocks	
Body, Motor, Control Arm bushings	Energy Suspension

### DRIVE LINE

Differential Gear Ratio	3.08:1 (Military HMMWV ratio)
Hub Ratio	1.92:1 (AM General Design)
Axles	12,100 lb GVW axels and geared hubs

### TOWING

Drawbar pull TBD

### AUXILIARY POWER UNIT

Engine Supplier	Steyr
Type	Model M160068-M VTI, 6-Cyl Diesel
Displacement	3.2L turbo charged with after cooler
Peak Output	160 kW / 218HP ; max torque 550 N·m
Fuel	Honeywell Synthetic Paraffin Kerosene (BIO SPK)
Fuel Freezing Point	-65 F
Alternate Fuels	Jet A, JP-8, Diesel #1, #2, Biodiesel
Lubricants	engine: TBD; gears: TBD
Capacity	55 gallons (dual 30 gal saddle tanks with, bladders)
Coolant (# gallons)	Propylene Glycol, TBD gal
Generator Supplier	UQM Technologies
Type	PowerPhase 150, Brushless, Permanent Magnet
Output Peak/Continuous	150 kW / 100 kW
Generator Coupling	K&N Engineering, DRS, Transfluid

### BATTERIES

Supplier	Electrovaya
Number of packs	2
Composition	Lithium SuperPolymer
Pack DC Voltage (nominal/peak)	355 / 388 VDC
Pack Usable Stored Energy	96S2P, 24 kWh
Pack Insulation	Pacor Aerogel, Arctic Fox cold weather kit

### TRACKS

Supplier	Mattracks
Model	YS3-865 Front / YS3-866 Rear
Ground Pressure (hard/soft surface)	4.68 psi / 2.89 psi*
Tread Width	18 in
Tread Ground Contact Length	56 in soft / 34 in hard
Distance Between Front Tracks	63 in inside / 99 in outside
Distance Between Front and Rear Tracks	96 in (8 ft)

### TRANSMISSION/TRANSFER CASE

NA	Independent Front/Rear Electric Drive
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### STEERING

Mechanical plus Electric Assist , Variable Ratio, 13/16:1

### BRAKES

Baer 4-Wheel Disc with Hydraulic Booster Assist

### ELECTRICAL

Auxiliary Load Continuous Output	24VDC, 50A; 12VDC, 50A; 375VDC, 198A
Plug-in Charger	Currentways
Input	100-240VAC; Output 3kW 225-450 VDC
Vehicle to Grid	TBD

### VEHICLE COMPUTER

Logic Supply	LGX Extended Temperature Fusion PT400
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### AUXILIARY HEAT

Supplier	Espar/Arctic Fox
Cab/cargo area (forced air)	Airtronic D5, 18,800 BTU
Systems Protection	Hydronic M10, 32,400 BTU
Fuel	Honeywell Synthetic Paraffin Kerosene (BIO SPK)
Consumption	.13 gal/hr (Airtronic), .16 gal/hr (Hydronic)

This work was conducted by a 30-member volunteer team led by Drive Around the World with support from talented teams at K&N Engineering, Big Dog Garage and Official Technology Suppliers listed below. Series hybrid design is a refresh of a DARPA hybrid-electric HMMWV program developed by DRS-TEM, PEI and Concurrent Technologies Corporation (CTC) through the Mid Atlantic Regional Consortium for Advanced Vehicles (MARCAV).





# PLUG-IN-HYBRID-ELECTRIC POLAR TRAVERSE VEHICLE #2 (PHE-PTV) SPECIFICATIONS

(Integration Period May, 2013 – January, 2015)



**DESIGNATION** "BUDDY 1"

### WEIGHTS AND DIMENSIONS

Curb Weight	9,740 lbs tires / 11,660 lbs tracks lbs
Payload	TBD lbs
Gross Vehicle Weight	TBD lbs
Length	207 in tires / 216 in tracks
Width (w/mirrors folded)	86 in tires / 102 in tracks
Height	91 in tires / 101 in tracks
Wheelbase	130 in
Ground Clearance	20 in tires / 24 in tracks

### PERFORMANCE (w/radial tires & GVW of TBD lbs.)

0 - 60 mph (tires)	7.2 sec*
Maximum Speed	93 mph*
Maximum Speed with Mattracks	45mph*
Gradeability	60%*
Range (tires/tracks)	

Hybrid mode	628 miles tires*/tracks TBD
Electric/Clean Air(TM) mode	32 miles tires*/tracks TBD

### ELECTRIC DRIVE MOTORS

Supplier	UQM Technologies
Type	PowerPhase 150, Brushless Permanent Magnet
Number	2
Total Shaft Hp	200 Hp
Total Stalled Wheel Torque	650 N·m
Coolant (# gallons)	Propylene Glycol, TBD gal
Suspension Coupling	K&N Engineering, DRS, Love Joy, BigDog

### SUSPENSION

Independent Double A-Frame	AM General
12,100 GVW Coil Springs and Hydraulic Shocks	
Body, Motor, Control Arm bushings	Energy Suspension

### DRIVE LINE

Differential Gear Ratio	3.08:1 (Military HMMWV ratio)
Hub Ratio	1.92:1 (AM General Design)
Axles	12,100 lb GVW axles and geared hubs

### TOWING

Drawbar pull TBD

### AUXILIARY POWER UNIT

Engine Supplier	Steyr
Type	Model M160068-M VTI, 6-Cyl Diesel
Displacement	3.2L turbo charged with after cooler
Peak Output	160 kW / 218HP ; max torque 550 N·m
Fuel	Honeywell Synthetic Paraffin Kerosene (BIO SPK)
Fuel Freezing Point	-65 F
Alternate Fuels	Jet A, JP-8, Diesel #1, #2, Biodiesel
Lubricants	engine: TBD; gears: TBD
Capacity	55 gallons (dual 30 gal saddle tanks with, bladders)
Coolant (# gallons)	Propylene Glycol, TBD gal
Generator Supplier	UQM Technologies
Type	PowerPhase 150, Brushless, Permanent Magnet
Output Peak/Continuous	150 kW / 100 kW
Generator Coupling	K&N Engineering, DRS, Transfluid

### BATTERIES

Supplier	Electrovaya
Number of packs	2
Composition	Lithium SuperPolymer
Pack DC Voltage (nominal/peak)	355 / 388 VDC
Pack Usable Stored Energy	96S2P, 24 kWh
Pack Insulation	Pacor Aerogel, Arctic Fox cold weather kit

### TRACKS

Supplier	Mattracks
Model	YS3-865 Front / YS3-866 Rear
Ground Pressure (hard/soft surface)	4.68 psi / 2.89 psi*
Tread Width	18 in
Tread Ground Contact Length	56 in soft / 34 in hard
Distance Between Front Tracks	63 in inside / 99 in outside
Distance Between Front and Rear Tracks	96 in (8 ft)

### TRANSMISSION/TRANSFER CASE

NA	Independent Front/Rear Electric Drive
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### STEERING

Mechanical plus Electric Assist , Variable Ratio, 13/16:1

### BRAKES

Baer 4-Wheel Disc with Hydraulic Booster Assist

### ELECTRICAL

Auxiliary Load Continuous Output	24VDC, 50A; 12VDC, 50A; 375VDC, 198A
Plug-in Charger	Currentways
Input	100-240VAC; Output 3kW 225-450 VDC
Vehicle to Grid	TBD

### VEHICLE COMPUTER

Logic Supply	LGX Extended Temperature Fusion PT400
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### AUXILIARY HEAT

Supplier	Espar/Arctic Fox
Cab/cargo area (forced air)	Airtronic D5, 18,800 BTU
Systems Protection	Hydronic M10, 32,400 BTU
Fuel	Honeywell Synthetic Paraffin Kerosene (BIO SPK)
Consumption	.13 gal/hr (Airtronic), .16 gal/hr (Hydronic)

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### Polar Traverse Vehicle - Technical Information

- ZERO SOUTH means **ZERO fossil fuels to the SOUTH Pole**—two vehicles will drive to the bottom of the planet on batteries and biofuels.
- Two ZERO SOUTH vehicles were built. They are mechanically identical in every way except for their exterior color. Vehicle #1 aka, "TUESDAY" (blue) was converted from a 1998 civilian Hummer H1. Vehicle #2, "BUDDY 1" (orange) was converted from a 1996 civilian Hummer H1.
- Parts retained from the original vehicles include, the chassis and the body. The Hummer drive line was retained, however the axles, differentials and geared hubs were upgraded with parts from a 12,100 GVW (armored) HMMWV. This was necessary for added strength since electric motors generate considerable torque immediately. 12,100 GVW HMMWV suspension and steering components were also used.
- Two ambulance hardtops from military HMMWVs (purchased on eBay for \$1600) were fitted to the top of each H1 vehicle. The hardtop is insulated and features considerable utility.
- The vehicles were built to operate in minus 60 and feature a thermal system with sophisticated climate controls and two ESPAR glycol heaters to channel heated coolant to warm the batteries, electric motors, inverters, engine and the fuel system.
- The expedition takes place in December which is the warmest month in Antarctica. Typical temperatures in December are minus 20F with lows as cold as minus 44F.
- For four wheel drive, a 150 Kilowatt (200 horsepower) UQM electric motor is coupled to the front differential pinion and an identical motor is coupled to the rear differential.
- The task of coupling the electric motors to the drive line was performed by K&N Engineering with design support from DRS-TEM. Coupling parts were supplied by LoveJoy, Inc. Mounting adapters were fabricated at Jay Leno's "Big Dog Garage."
- Electricity is generated using a third UQM electric motor connected to the flywheel of a Steyr (Austrian) 6-cylinder turbo diesel engine using a Transfluid torsional coupler. This engine is compliant with Euro-IV emissions standards and produces 160 Kilowatts or 218 horsepower.
- The EV architecture is referred to as a series hybrid and similar to a diesel-electric locomotive.
- During the expedition, the diesel engine/generator will run on renewable aviation biofuel known as Synthetic Paraffin Kerosene (bio-SPK). This fuel has a freezing point of -65F and is produced from an EPA-approved blend of inedible oils (used cooking oils, yellow and white greases) using a downstream technology that has not been made public.
- Twin, custom 30-gallon fuel tanks placed in the wheel wells provide storage for 55-gallons of fuel. Each tank has double-wall, rubber lining supplied by Aerotec Services. Fuel can be cooled or heated using an Arctic-Fox fuel pickup tube. An electric fuel heater is also integrated.
- The front and rear differentials were flipped so the electric traction motors could be mounted outboard. This provided room between the frame rails for a five-foot battery box which allowed packaging of additional batteries for greater all-electric range.
- Energy is stored in two battery packs for redundancy. Each pack uses four, 97-volt Electrovaya Lithium SuperPolymer modules connected in series for a total of 388 volts and stored capacity of 24 Kilowatt hours. The Steyr/UQM generator is set to maintain a constant bus voltage of 375 volts.
- The battery box walls, floor and lid are insulated with Spaceloft -- an aerogel blanket produced by Pacor. The battery modules sit on an Arctic Fox heater plate. Hot 160-degree glycol is pumped through pipes beneath this plate to convection heat the batteries. Once the vehicle is operational the batteries produce their own heat and are cooled using the same system.
- The vehicle's all-electric range on tires is 32-miles. Range in hybrid mode on tires is 628 miles. Maximum speed on tracks is 45 MPH.

**Drive Around the World** is a non-profit producer of dramatic, worldwide adventures for charitable causes. We are supported by civic and foundation grants along with a courageous group of sponsors and individual donors.

Vehicle integration by Drive Around the World with support from talented teams at K&N Engineering, Big Dog Garage and Official Technology Suppliers. Series hybrid design is based on DARPA-funded, hybrid-electric HMMWV programs created by DRS-TEM, PEI and Concurrent Technologies Corporation (CTC). \*All estimates based on DARPA vehicle performance after integration of new components. Actual values to be assigned during testing.





# POLAR TRAVERSE AIRSTREAM (SNOWSTREAM) SPECIFICATIONS

(Integration Period February 5, 2011 – October 1, 2013)



## DESIGNATION "SNOWSTREAM" IDENTIFICATION

Year of Manufacture	1962
Serial number	22DS SO965
	6211
	S-0965 3149
	DoH no A-51020

## AIRSTREAM WEIGHTS AND DIMENSIONS

Airstream Trailer Weight	3170 lbs
Payload	TBD lbs
Gross Vehicle Weight	TBD lbs
Tongue Weight	TBD lbs
Trailer Length (bumper to hitch tongue)	275 in (22' 11")
Trailer Interior Length (wall to wall interior)	228 in (19')
Width	93 in tracks (7' 9")
Height (ground to roof vent)	103 in (8' 7")
Hitch ball to axle distance	162 1/2 in
Track width (measured from outside edge of tire)	84 in
Ground Clearance	TBD
Hitch Setup	2" ball
Axle	Henschen Dura-Torque
Hub Bearing	TBD

## SLED SPECS, WEIGHTS AND DIMENSIONS

Designer	Herb Setz, Peace River, Alberta, Canada
Fabricator	Superior Steel Products, Caldwell, Idaho
Sled weight	4,200 lbs
Payload	5,800 lbs
Gross Vehicle Weight	10,000 lbs
Tongue Weight	TBD lbs
Floation/ground pressure	528 Sq in, TBD psi
Sled Length (with / without tow bar)	35 ft / 23 ft 6 in
Sled Height (with / without trailer)	10 ft 6 in / 2 ft
Ski Length	22 ft
Ski Width	12 in
Ski Keel	dual rod, 3/4 in
Track Width (inside skis / outside skis)	8 ft 9 in / 10 ft 9 in
Tow Bar Length	10 ft 5 in
Hitch Setup	3" ring
Suspension	dual, front/rear pivots for uneven terrain

## PRIME MOVER VEHICLE DIMENSIONS

Length	207 in tires / 216 in tracks
Width (w/mirrors folded)	86 in tires / 102 in tracks
Height	91 in tires / 101 in tracks
Wheelbase	130 in
Ground Clearance	20 in tires / 24 in tracks
Distance from vehicle bumper to rear of ambulance hardtop	19 in
Vertical distance from receiver square to ground	32 in
Tread Width	18 in
Tread Ground Contact Length	56 in soft / 34 in hard
Distance Between Front Tracks	63 in inside / 99 in outside
Distance Between Front and Rear Tracks	96 in (8 ft)

## EXPEDITION REQUIREMENTS

Anticipated Towing Distance	≤ 1500 miles
Anticipated Towing Speed	≤ 15 mph
Route	Union Glacier Camp to South Pole, roundtrip
Conditions	2,297 feet to 9300 feet, nominal grade

## ELECTRICAL

Auxiliary Low-Voltage Power	24VDC, 50A; 12VDC, 50A
Auxiliary High-Voltage Power	375VDC, 198A
Pack Usable Stored Energy	96S1P, 12 kWh

## VEHICLE COMPUTER

Shuttle

## AUXILIARY HEAT

Forced Air Heater	Espar Airtronic D5, 18,800 BTU
Quantity	2
Fuel	Honeywell Synthetic Paraffin Kerosene (BIO SPK)
Fuel Freezing Point	-65 F
Consumption	.13 gal/hr

## INSULATION

Interior Insulation	Pacor SpaceLoft
Type	Aerogel Fiberglass Blanket
Thickness	1 in
R-Value	10.3

## COMMUNICATIONS

VHS radio	ICOM
Channels	5
Frequencies	151.6250 - 151.9550 (tx & rx) tone code 162.2
Satellite Communication	IRIDIUM

## ACCOMODATIONS

Bunks 6

## FOOD PREPARATION

Water boiler	Electric kettle, 1200 watts (primary)
	JETBOIL SUMO modified for kerosene (backup)
Cook stove	MSR XGK-EX (emergency)

## TANK CAPACITIES

Fresh Water	TBD
Grey Water	N/A
Black Water	wagbag disposal in outside freeze bin

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# ZERO SOUTH

## Polar Traverse Airstream - Technical Information

- ZERO SOUTH means **ZERO fossil fuels to the SOUTH Pole**—two vehicles will drive to the bottom of the planet on batteries and biofuels.
- The Airstream logo features trailer being towed by a bicycle to convey a lightweight and durable trailer. The Airstream was selected for these characteristics and overall utility.
- The trailer wall insulation was retrofitted with an aerogel blanket called Spaceloft, made by Pacor. The cavity beneath the floor contains five inches of spray foam.
- The vehicle was built to operate in minus 60.
- The vehicle features sophisticated climate controls and two ESPAR forced air heaters to warm the interior.
- The interior heaters run on renewable aviation biofuel known as Synthetic Paraffin Kerosene (bio-SPK). This fuel has a freezing point of -65F and is produced from an EPA-approved blend of inedible oils (used cooking oils, yellow and white greases) using a downstream technology that has not been made public. The heaters consume one gallon for every six hours of operation.
- The expedition takes place in December which is the warmest month in Antarctica. Typical temperatures in December are minus 20F and may get as cold as minus 44F.



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