Aluminium Metal
Primary Production

TECHNICAL SPECIFICATION

Yellow Vehicles

INTERNAL

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Changes from last revision:

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CONTENTS

1 Application and purpose

This specification is applicable for deliveries of special «yellow» vehicles to Hydro Aluminium Metal Plants. Divergent design can be accepted but shall be specified in the quotation and approved by Company before contract signing.

Requirements set out in appendix A, column B and C shall be confirmed by Contractor (column D and E) and returned in excel format.

2 Definition

Yellow vehicles: Special vehicles designed for production of aluminium or standard vehicles modified for aluminium production.

Vehicle: Vehicle as specified in technical specification

Company: means Hydro Aluminium AS, Norway

Contractor: means the supplier of the vehicle

3 Responsibility and authorithy

The Hydro Aluminium P-team Vehicles is responsible for all revisions and updates regarding yellow vehicles specifications. Members of the P-team, as plant contacts and coordinators, are responsible for inquiries in their respective units.

4 Requirements

4.1 General requirements

1. The Contractor is responsible for delivering the vehicle with CE marking and the declaration of conformity that states that the vehicle is designed and constructed according relevant European Directives.
2. The vehicle shall be delivered according to European/Norwegian vehicle regulations and the Norwegian Working Environment Act.
3. Original Spare parts compatible Spareparts with better or same specifications is to be available for purchase at least ten years after delivery of vehicle.

4.2 General technical requirements

1. The vehicle and its functions shall be designed to operate in areas where it is exposed to electromagnetic fields.
2. The vehicle shall be able to work in environments with ambient temperatures. Exposure to radiation heating must also be considered.
3. The vehicle shall be able to work in environments where it can be exposed to dust.
4. The speed of the vehicle shall be able to be controlled and limited to two different speed limits. Normally one for indoor and one for outdoor driving. This shall however not compromise the safety and comfort of operations and shall be approved by Company.

See appendix A for detailed specifications.

4.2.1 General equipment

All lights shall preferable be of LED type.

1. Driving lights, direction lights, braking lights, rear lights, working lights, cabin light and blue light in back and front (to alert nearby walking personnel)
2. Blue light shall signal in driving direction only and automatically turn on when moving
3. Minimum 2 working lights
4. Mirror on both sides of vehicle (and inside if necessary) with satisfactorily visibility
5. 6kg NOA ABV dry powder fire extinguisher mounted as close to the cabin entry as possible
6. Sound signal and flashing lights when reversing
7. Signal horn
8. Reverse camera if inside mirror is not enough
9. Windscreen wiper
10. DAB+ Radio

4.2.2 Maintenance

Components shall be easily accessible for efficient, ergonomic and safe maintenance. The vehicle must be prepared with platforms, steps, railings, etc. to ensure safe access to components during maintenance and other work. On heavy components lifting lugs or bolted lifting holes shall be considered. Special consideration to access must be given if work on the vehicle shall be carried out at height.

5 Engine

5.1 General

See attachment 2 for preferred components/suppliers.

5.2 Diesel engine load

1. The method used to limit the speed of the vehicle shall not reduce the lifetime of the combustion engine or other components.
2. The diesel engine of the vehicle is to be dimensioned to handle the conditions and running cycles.
3. The vehicle must be able to drive on roads with an inclination of minimum 6° and 5 km/h with maximum load of 85% of max rated effect on the diesel engine.

5.3 Basic Instruments diesel engine

1. Diesel engine alarm is to be instrumented to emit a sound and display a light if high temperatures or low oil pressures occur.
2. Tachometer.

3. Surveillance of oil pressure, temperatures, oil level warning with an appropriate warning light.
4. Electronic measurement of oil level.

5.4 Air filtration diesel engine

1. Air filter shall be dimensioned for minimum double capacity of the engine's requirement
2. Precleaner shall be dimensioned to the actual air requirement of the engine and shall not require to be emptied manually.
3. The air filter shall be dimensioned for a service interval of minimum 500 operating hours.
4. Hose connections shall be made by steel reinforced rubber, and two set of hose clamped together with glue.
5. In the turbo a silicon-based solution should be used to handle the high temperatures.
6. Filter house shall be completed with main and secondary filter.

5.5 Use of electrical engine in place of diesel engine

5.5.1 General

1. Power requirements and other requirements as described above (for combustion engine) can deviate from specification when using electrical engines. In this case the supplier must recommend specifications according to functional requirements of the vehicle.
2. Instruments must indicate with warning signal when max. allowed engine temperature is reached.
3. Instruments must indicate current capacity of battery package.
4. Specifications of yellow vehicles equipped with electrical engines are not final. Deviations are communicated to Company and solutions are agreed upon.

5.5.2 Battery and re-charging

1. The battery package must be protected against outer factors such as e.g. metal splash. Special considerations must be taken in areas where vehicle is operated close to electrolysis cells and hence liquid metal.
2. Battery package/battery must have enough air ventilation/cooling.
3. The recharging point and cables will be handled by vehicle operators and therefore must be easily reachable and usable. The vehicle should be design so that it can be parked and recharged with its front towards driving direction (no need for reverse movement when driving from parked positions). Deviations to be agreed upon with Company and Contractor.
4. Battery capacity requirement: minimum 8 hours of operation as described by functional requirements.
5. On vehicles where the battery can/will be changed when discharged with a fully charged "back-up battery" in order to maintain operations, the supplier must ensure that vehicle is

designed so that this functionality is maintained in a safe and efficient manner. The solutions for this must be agreed upon between Company and Contractor.

6. Charger to be dimensioned to min. 20% of battery max capacity. The time it takes to recharge the vehicle (0-100%) must be max 8 hours.
7. Voltage 3x400V if nothing else is communicated to supplier.
8. Effect of magnetic fields must be evaluated when implementing electric vehicles.

6 Hydraulic power unit

6.1 General

The hydraulic system must be built to maintain purity of at least 17/15/12 (ISO 4406:99) or better. Hydraulic system to include:

1. A filter indicator to read the condition of the filter.
2. Hydraulic tank with: Level glass, bolted top plate, breathing filter 3 µm, partition, Filling spout: 3/4" quick release coupling and 1” Draining off ball valve.
3. Drain off point easily accessible under and in the middle of width.
4. It is mandatory for reservoirs that are placed high on vehicle to have a shut off valve on the oil outlet.
5. All tank mounts must be fixed through a doubling plate.
6. Hydraulic cylinders according to DIN norms if nothing else is communicated.
7. Testing point for pressure of type Parker series 3, M16X2.
8. Accumulators to be fitted with a solution that safely vents out the gas in case of overtemperature.
9. Components according to SAE/DIN norms. Deviations must be communicated to and approved by Company.
10. For systems that can come in contact hot surfaces or ignitions sources must use a fire resistant fluid.

6.2 Hoses, tubes and couplings

1. All hydraulic couplings shall be of type EO2.
2. Hoses and tubes to be clamped properly to avoid gnaw and vibrations.
3. Fixed pipes are preferred instead of rubber hoses where it is possible.

6.3 Valves

1. Use valves according to ISO standard if nothing else is specified.

6.4 Drive and work hydraulics

1. Hydraulic pumps shall be connected to engine through a gearbox if more than one pump is used.

2. See attachment 2 for approved and preferred components.

7 Drive, steering and brakes

7.1 Brakes

1. Normal drive brakes to be operated by foot pedal.
2. Hand brake/parking brake to be of type overrun brake.
3. There must be a system to disengage the brakes in case towing is necessary. This must also be described in a separate procedure in user handbook.

7.2 Drive

Drive shaft shall be of type as specified in attachment 2. Deviations to be agreed with Company in cases where this is not possible.

7.3 Steering

Hydraulic steering according to component list attachment 2. Different solutions (electric solution as an example) is to be agreed with Company.

7.4 Suspension

Supplier to propose type of suspension. Hydraulic suspension is preferred by Company.

7.5 Wheel hub

If possible, wheel hub to be fabricated from one piece (not several welded elements).

8 Electrics

8.1 Instruments

Vehicle shall be completed with:

1. Fuel gauge. Battery indicator if fitted with electric motor/drive.
2. Temperature gauge for engine and hydraulic oil.
3. Engine hours meter
4. Ignition switch
5. Warning indicator (lamps) for oil pressure, charging voltage, direction switch, parking brake, reverse lights and engine temperature.
6. Direction switch: forward – neutral – reverse
7. Stepless speed regulation with foot pedal.
8. All equipment to be prepared for condition-based maintenance. E.g. vibration, temperature and pressure monitoring. Information should be possible to retrieve without special equipment made by supplier.

It is preferably to present information above on an LCD display fore clean cabin.

8.2 Electric specifications

Vehicle shall be completed with:

1. Voltage: 24V
2. Main power switch shall be mounted easily accessible close to the cabin door opening and connected to the negative pole of the battery.
3. Main power switch shall be prepared for “Lock Out Tag Out” LOTO. This is to ensure safe lock down.
4. Minimum two emergency stops. One emergency stop shall be placed next to main power switch and one shall be placed inside cabin easily accessible from entire cabin.
5. Relays, electric switches and fuses mounted in dust proof cabinet (steel or aluminium IP65).
6. NATO-contact for auxiliary start. *Specific for Hydro Husnes: Grey CB 175 (Bruco machine. Eq. number 604911000).*
7. Optional electric equipment to switched on/off with ignition switch.
8. Driving lights automatically turned on when starting vehicle.
9. Dynamo designed with 20% overcapacity when all equipment is in operations. See Attachment 2 for preferred type.
10. Windshield wiper shall have an interval function.
11. Electrical wires that is exposed to heat radiation must be of a suitable classification. Documentation on the chosen wire is to be a part of as built documentation.
12. Cables that is exposed to large amount of movement or heat must be considered to have plugged solutions at each end for ease of replacement.

9 Chassis

9.1 General

1. Towing point for vehicle easily accessible and adapted for the different smelter. requirements.
2. Surface treatment/painting: 1 layer of primer 75 µm + 2 layers enamel finishing coat 75 µm, preferably without isocyanates.
3. Standard colour: RAL1028 – *Melon Yellow*
4. All vehicles must have a defined and described method of lifting.

9.2 Cabin

1. Cabin must be water, gas and dust proof.
2. Cabins inner dimensions: Length min. 1400mm, width min 1200mm and headroom minimum 1500mm.

3. Drivers chairs must be ergonomically adapted for operators of different sizes and shapes. When completed with rotating driver's chairs, special considerations must be given to 360^0 space requirements.
4. Heat reflecting laminated, two layers glass in windows. Vehicles exposed to heat radiation may require 16mm filled with gas in void between layers.
5. Windows to be mounted in rubber strips/gasket.
6. Insulation should be glued and properly secured.
7. Driver's seat to be completed with min 3-point seatbelt.
8. Instructor seat/chair to be completed preferably with 3-point seatbelt.
9. Vehicles entrance /exit must be designed with stairs and holding points when required. Trip hazards must be avoided. Landing height 250-300mm, riser range 200-250mm and tread depth min. 200mm. Surface on steps with friction to avoid slipping.

9.2.1 Tilting of cabin

1. Use 24V electrohydraulic power unit. Deviations to be communicated and agreed upon with Company.
2. Hydraulic power unit to be used as back-up for defined functions.
3. Cover/cabin must be secured against accidental movement in both directions when in lifted/open position.

10 Working environment and ergonomics

10.1 Noise

Maximum noise levels to be accepted by Company are:

- Outside of cabin: 78 dB(A)
- Inside cabin (incl. Air Condition): 75 dB(A)

Measured according to *ISO362* (Motor vehicles accelerating) and *ISO5128* (Inside motor vehicles)

Measurements must be documented and is a part of documentation for handover.

10.2 Air Condition and ventilation

A system which ensures the comfort and safety of operators by controlling the cabin pressure and exchange of air from the outside is required.

Operators shall not be exposed to dust, smoke, gases, etc. when inside the cabin. If this is not possible; the general rules for exposure time through an 8 hours period are:

- Fluoride <=0,05 mg/m^3
- Dust <=1,5 mg/m^3
- PAH <=0,04 $\mu g/m^3$
- SO_2 <= 0,6 mg/m^3

The requirements of air condition mounted inside cabin shall be evaluated for the specific vehicle. Air condition equipment shall satisfy the following specifications:

1. Air-condition type MKKAC 650 for larger cabins is preferable
2. A separate pump or a distribution valve is to be used to keep a constant RPM within its parameters in the AC while idling.
3. Nozzles shall be placed to ensure good air distribution in cabin and by windows to prevent air draft in neck region.
4. Temperature control to regulate to selected temperature within 18-26 degrees Celsius, under all working condition.

10.3 Vibration

Vibration data to be presented in documentation delivered by the supplier.

Whole body vibrations less than 0, 3 m/s² (A8) and hand/arm vibration less than 1,5 m/s^2 according to EN 14253 and ISO 2631-1.

10.4 Ergonomics

Driver's seat must be dimensioned with regards to operators of different heights and according to working authority regulations.

1. The steering wheel shall be possible to adjust up/down and back/forth according to the operator's requirements. Steering wheel approximately 4 turns from max left to max right.
2. Arms rest to be prepared for joysticks.
3. Drivers chair to be prepared with support for operator's neck.
4. Driver seat should be adjustable minimum 300mm up and down, unless otherwise agreed.
5. Pneumatic suspension on driver's seat is preferred.
6. Handles and instrument panels shall be placed so that they easily can be controlled and read from driver seat.
7. When rotating seat is to be fitted, steering wheel is to turn with the driver's seat. This only applies when the steering wheel is to be used in multiple positions.

11 Lubrications

All grease points are to be easily accessible and collected where possible.

Automatic grease systems are mandatory for all grease points with frequent interval lubrication (<300 working hours/1 month).

Grease chart shall be a part of user manual.

12 Documentation

Attached documentation must be in 3 paper and one electronic copy. Documentation shall as far as possible be in Norwegian.

Electronic documentation should also as far as possible be editable and compatible with Microsoft office.

Documentation must be of:

1. Instruction manual with a setup for first line maintenance.
2. Recommended maintenance plan with measures and interval. Electronic variant should also be editable.
3. Parts list delivered filled out on added template Appendix 3.
4. Recommended spare parts list Appendix 4.
5. Maintenace manual.
6. Mechanical, pneumatic and electric drawings.
7. Layout drawing.
8. Detailed drawings with measures printed.
9. List of hoses with dimensions, coupling and hose/rubber type.

13 Training

For new vehicles, the supplier shall arrange for maintenance training of mechanics/technicians (min 1 day) and training of operators. Details regarding these training courses are to be agreed between Company and Contractor.

In accordance with FOR-2011-12-06-1357 «Forskrift om utførelse av arbeid» a documented safety training shall be performed when Hydro is taking over the vehicle.

This training shall as a minimum include as a theoretical and practical part:

1. Vehicle build up and functions
2. Safety
3. Vehicle operation
4. Running and maintenance
5. Troubleshooting

14 Attachments

Attachment	Name	Date
Attachment 1	Technical Specification plant spesific	2021-03-01
Attachment 2	Vehicle or machine registration card	2016-03-01
Attachment 3	List of Preferred components	2016-06-27
Attachment 4	Recommended spare parts list template	2021-03-01

15 References

AMS. (november 2008 rev 06). Sjekkliste for Innkjøp/leie av kjøretøyer.

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