The Engineering Society For Advancing Mobility Land Sea Air and Space

400 COMMONWEALTH DRIVE, WARRENDALE, PA 15096

AEROSPACE RECOMMENDED PRACTICE

ARP 4047

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Submitted for recognition as an American National Standard

AIRCRAFT DEICING VEHICLE SELF-PROPELLED, SMALL CAPACITY

1. SCOPE: This aerospace recommended practice covers requirements for a self-propelled, boom type aerial device, equipped with an aircraft deicing fluid spraying system. The unit shall be highly maneuverable for deicing all exterior surfaces of intermediate size aircraft, e.g. DC-9, B-727 and B-737. The vehicle will also be used for aircraft maintenance and inspection. The vehicle shall be suitable for day and night operations.

2. APPLICABLE DOCUMENTS: The following documents or portions thereof of the issue in effect on the date of the purchaser's controlling specification form a part of this ARP to the extent specified therein.

2.1 SAE ARP 1247 (latest edition). General requirements for aerospace powered mobile ground support equipment.

2.2 ANSI A92.2-(latest edition) - For vehicle-mounted elevating and rotating aerial device.

2.3 CSA (Canadian Standard Association) C-225 (latest edition) Vehicle-mounted aerial devices.

2.4 OSHA - Safety and Health Standards 29 CFR 1910.

2.5 SAE ARP 1838. Pictograms for ground support equipment.

3. TECHNICAL REQUIREMENTS:

3.1 General Description: The unit shall consist of a suitable self-propelled chassis, an aerial device with personnel basket constructed and mounted in accordance with national safety standard, fluid supply tank(s), a fluid pumping system and heater for applying heated deicing fluid to all necessary aircraft surfaces. An auxiliary engine will power the spraying system and aerial device and be independent of the propulsion engine. All major items shall be enclosed in a compartmentized body meeting recognized appearance and functional standards of the truck body industry.

3.2 Basic Performance Features:

3.2.1 The primary function of the vehicle shall be to apply heated deicing fluid mixtures from a variable height boom to the surfaces of stationary aircraft while traversing their perimeter. A hose stored in a compartment shall also be fitted for ground use. The vehicle shall be acceptable for use around terminal gate areas, airport service roads and aircraft service ramps.

3.2.2 The unit design must provide a safe and stable configuration for maneuvering about the aircraft with the boom in any possible position at speeds up to 6 km/h (3.75 mph) with fluid and fuel tanks at minimum and maximum operating levels. A highway speed of at least 80 km/h (50 mph) is required with fluid tank(s) at minimum levels. A 40 km/h (25 mph) speed is required with fluid tank(s) at maximum levels.

3.2.3 The aerial device, when extended, shall provide a basket floor to ground height of at least 10.06 m (33 ft). The personnel basket capacity shall be at least 140 kg (308 lb) with at least 0.61 m x 0.61 m (2 x 2 ft) floor area to accommodate one standing person.

3.2.4 The deicing fluid system shall provide a delivery rate at the personnel basket spray nozzle of at least 300 liters/min. (78 U.S. gpm) at 6.68 to 7.38 kg/cm^2 (95 to 105 psi) pre-nozzle discharging pressure with the boom fully elevated.

3.2.5 The deicing fluid supply tank(s) shall be constructed of non-corrosive material. The tank(s) will provide approximately 2,700 to 4,600 liters (713 to 1215 U.S. gal) fluid minimum usable capacity.

3.2.6 The deicing fluid system shall be designed for fluid temperatures of -40°C (-40°F) to 96°C (205°F).

3.2.7 An enclosed flame internal combustion type heater or electric heater (see paragraph 3.9.2) with an automatic safety control system shall be capable of raising the temperature of 2,700 liters (713 gal) of fluid from 1.7°C (35°F) to 82.2°C (180°F) within 1 hour.

3.2.8 Power distribution shall be so arranged that vehicle propulsion, fluid spraying, and boom positioning may be accomplished simultaneously with no detrimental effect upon any system.

3.2.9 A separate engine shall be provided to drive the fluid, blower and hydraulic pumps on all vehicles using a standard truck chassis.

3.2.10 Sufficient fuel tank capacity is required for all engines and the combustion heater for continuous deicing operation at rated output for a minimum of four hours without refueling. Design shall provide 7.5-19 liters (2-5 U.S. gal) of usable fuel for the propulsion engine after supply is depleted for auxiliary engine and heater. Design shall provide for the shutdown of the heater first. The Vendor shall supply data on the specific fuel consumption at rated output for each engine and the fluid heater.

3.2.11 Operation of the spray fluid system shall not be contingent upon operation of the heater. Operation of the elevating boom and vehicle propulsion shall not be contingent upon operation of the fluid spray system (Ref. paragraph 3.4.15). Operation of the boom elevation, fluid spray and heater systems shall not be contingent on operation of the vehicle propulsion engine.

3.3 Chassis Description:

3.3.1 The chassis shall be a standard, current truck model offered by a leading automotive manufacturer.

3.3.2 The vehicle driver shall be located at the left side of the chassis and shall have the maximum unobstructed view of the operator and basket under all operating conditions. The left side (looking forward) shall normally be considered as the working side for location nearest to the aircraft being serviced, and contain external instruments and controls.

NOTE: The above may be reversed for countries that drive on the left hand side of the road.

3.3.3 The chassis shall include an enclosed, heated cab for the vehicle driver and a passenger.

3.3.4 The vehicle shall be of minimum overall length and width, consistent with stability requirements. Maximum width shall be limited to 2.44 m (96 in) and maximum height limited to 4.12 m (13 ft 6 in) unless otherwise specified.

NOTE: These dimensions may be different according to national highway regulations.

3.3.5 In addition to standard cab equipment (heater/defroster, lights, electric wipers and washer, rear view mirros, etc.), the roof of the cab shall be fitted with a 76.2 x 38.1 cm (30 in x 15 in) or larger observation window and electric wiper. This shall be located for overhead viewing from the driver's position.

3.3.6 The vehicle drive train shall be equipped with automatic transmission.

3.3.7 Power steering and power assisted dual braking system shall be provided.

3.3.8 The brake pedal shall be fitted with a non-slip material contact face.

3.3.9 The parking brake shall be applied by over centre operated lever, foot operated ratchet, or spring set mechanism.

3.3.10 The standard chassis shall be rated to sustain loads imposed by the vehicle at speeds up to 80 km/hr (50 mph) for over-the-road operation with the fluid tanks at minimum level and 40 km/hr (25 mph) with fluid tanks full.

3.3.11 Tow hooks shall be installed on the chassis structure, two at front and one at rear.

3.3.12 Snow/mud tread tires shall be provided on drive wheels.

3.3.13 Drive wheel tire clearance shall be adequate for the installation and operation of chains, and any vulnerable components shall be suitably protected.

3.3.14 Storage batteries shall be of the heavy duty type. Vehicle electrical system shall be based on 12 VDC or 24 VDC. Fluid heater circuits shall be 208/240 VAC.

3.3.15 Alternators shall be installed that supply 100% of the maximum vehicle electrical steady load at engine idle rpm.

3.4 Aerial Device Description:

3.4.1 The aerial device and its installation on the vehicle must conform to all national safety and stability regulations in all respects other than electrical insulation requirements. Boom elevating hydraulic cylinders shall be equipped with pilot operated check (or holding) valves bolted directly to the base of the cylinders to prevent inadvertent boom lowering from a hydraulic system pressure loss. All pivot points shall have easily accessible grease fittings. The personnel basket shall have a self-adjusting mechanism to maintain a vertical attitude for all boom positions. Outriggers or other ground contact devices shall not be required to obtain the specified stability.

3.4.2 The vehicle and boom shall remain stable with the fluid tanks empty, the boom at any attitude, one occupant 113.4 kg (250 lb) working in the basket, and a 75 km/hr (46 mph) wind from any direction. Spring lock out devices may be utilized to maintain stability when boom is elevated, if required. See SAE ARP 1247.

3.4.3 Boom rotation shall be achieved by either turret swing through a 360 deg arc in either direction (but not continuously rotatable requiring slip ring design), or by employing a fixed boom on a highly maneuverable vehicle which provides similar operational flexibility.

3.4.4 The aerial basket shall be designed to position an operator to effectively apply fluid to the upper areas of aircraft control surfaces, wings, empennage and fuselage.

3.4.5 Stability and safety shall be paramount in the boom and basket design. Operation of the boom and its controls shall be smooth and positive.

3.4.6 The aerial basket shall be equipped with a complete set of controls which will permit the operator to move the boom and basket through any of its motions.

3.4.7 Duplicate controls shall also be provided at a location readily accessible to the driver (preferred) or in the vicinity of the boom base. A selector valve shall be provided at the lower station (next to the duplicate controls) to permit selection of the operating station between either the basket or vehicle location. The lower controls shall override the basket controls in any configuration.

3.4.8 All control levers shall directionally agree with boom movement, be of the "dead-man" type, and large enough for grasping with a gloved hand. They shall be identified with permanent non-fading placards or pictograms per ARP 1838. Controls shall be positioned at the rearward edge of basket and protected from fluid spray and/or inadvertent snagging from lines or hoses.

3.4.9 The normal position of the personnel basket when at rest shall be forward and over the cab for optimum control and view when approaching aircraft or work area.

3.4.10 An enclosed basket shall be 0.61 x 0.61 x 1.07 m (2 x 2 x 3-1/2) at least. The basket floor shall be covered with expanded metal or suitable equivalent to prevent ice buildup and permit moisture drainage. A non-marking rubber bumper shall be installed on the external bottom and the bottom edges of the basket.

3.4.11 The aerial basket shall be provided with safe and easy entry and exit with positive latches on entry gates and/or retainer bars. The door or bar shall permit easy entry of an average sized operator dressed in winter protective clothing and shall open inwards into the basket. One safety belt with lanyard shall be provided with attachment points on boom at basket level.

3.4.12 The basket shall be fitted with a cushioned protective "holster" for storage of the hand held spray gun. The holster shall be mounted on the outside of the basket, shall be of open construction to permit drainage, and shall be large enough to permit easy gun stowage and removal.

3.4.13 An emergency stop switch shall be provided in the basket to freeze all boom movement and/or shut down fluid pump and heater. See also paragraph 3.8.1.

3.4.14 Design of the aerial device and its attachment to the chassis shall be such that periodic structural inspection can readily be carried out without major dis-assembly.

3.4.15 An emergency hydraulic pump and motor powered by the chassis 12V system shall be provided, which will enable the aerial device and loaded basket to be maneuvered and lowered in the event of auxiliary engine malfunction/shut-down. Duplicate controls shall be located at the basket position and at the base of the boom, or be readily accessible to the driver.

3.5 Fluid System Description

3.5.1 The fluid dispensing system shall provide the following features:

a) 2700 to 4600 liters (713 to 1215 U.S. gallons) capacity (minimum usable) non-corrosive tank(s) for glycol mixture, or as designated by customer.

b) Spray nozzles at basket location and ground level location.

c) Complete drainage of fluid tank(s), supply and return piping from nearest check valve by single tank drain valve. All lines after check valve through heater and up boom to basket must be capable of being drained or purged.

3.5.2 The vehicle's fluid handling system shall be designed to be compatible with all types of commercially available deicing fluids. See Optional Equipment 3.9.1 for Type II fluid requirements.

3.5.3 Non-corrosive fluid tank(s) shall be adequately baffled to prevent undue fluid motion and starving of the fluid pump during maneuvering. Return fluid shall be introduced near the bottom of the fluid tank(s) as remote as possible from the outlet to pump. A suitable vent, overflow, manual fill and liquid level gauge graduated in 500 liter or 100 U.S. gallon increments, shall be provided on the tank. The tank(s) shall be sloped or shaped for complete drainage and have a manhole with cover, in the top of the tank(s), for access and cleaning.

3.5.4 Tank drainage fittings shall be 5 cm (2 in) minimum with "Teflon" lined valves mounted close to the tank(s) with operating handles at the side of the truck. Drainage of each tank should take no more than 10 minutes.

3.5.5 A manhole type gravity fill opening with an attached cover shall be provided for replenishment of the tank(s). Adequate expansion space shall remain after filling to prevent fluid overflow or tank pressure build-up during heating.

3.5.6 The fluid pump shall be self-priming and capable of running dry without damage for a period of three minutes. Suitable non-corrosive strainer protection shall be installed in the pump inlet of a design preventing pump cavitation.

3.5.7 Plumbing, pump, heater, valves, fittings, seals, etc., shall be compatible with the cold or heated fluids to which they are exposed. Anticipated fluid types are ethylene and/or propylene glycol base deicing fluids. A safety valve shall be provided on the discharge side of the pump to prevent damaging system components.

3.5.8 System design shall permit easy non-hazardous access to components for servicing or removal. Isolation shut-off valves shall be installed on the fluid tank(s) and at other locations where large spillage would occur if a line was opened.

3.5.9 The basket shall be equipped with a portable gun type spray nozzle to be held by the operator. This nozzle shall be capable of applying an effective deicing fluid spray pattern to the top of the fin of DC-9, MD 80, B-727 and B-737 aircraft [approximately 11.6 m (38 ft)].

3.5.10 The spray pattern shall vary from a fan shaped spray to a solid stream as selected by the operator. The variation in spray pattern will be accomplished by using an adjustable nozzle. The operator shall have full control of fluid flow by a nozzle rate-of-flow adjustment and the open-close lever.

3.5.11 The hose to spray gun coupling shall be of a swivel type that cannot become inadvertently disengaged while fluid is present under pressure in the fluid lines.

3.5.12 The weight of the spray gun and unsupported hose shall not exceed a 15 kg (33 lb) lifting and/or reaction force when the gun is activated or shut off.

If reaction forces are too great for a hand held spray gun, a fully maneuverable turret type gun permanently mounted on the basket is acceptable.

3.5.13 A 15.24 m (50 ft) minimum long ground hose and hand held spray nozzle shall be installed and stowed in a lower compartment of the truck body for underwing and landing gear deicing. The nozzle shall be swivel mounted and provide a flow of 30-75 liters (8-20 U.S. gpm). A shut-off valve (90 deg turn) shall be installed immediately up-stream of the hose.

3.5.14 The fluid heater shall be suitable for continuous operation on the airport and during operation of the vehicle while in motion when deicing aircraft. The heater combustion chamber shall be of the closed type and shall meet the approval of the airport authorities for operation on airport areas.

3.5.15 Location of the heater in the fluid system shall be down-stream of the fluid pump so that fluid supplied to spray nozzles can be at a combination of tank temperature plus heat rise of the fluid passing through the heater.

3.5.16 The heater shall be equipped with a suitable temperature controller to maintain the fluid temperature at a maximum setting +3° from 77° to 93°C (+5° from 170° to 200°F) under all operating conditions after the initial temperature is reached. The heater shall also incorporate a separate over temperature shut down switch set at 96°C (205°F), with manual reset.

3.5.17 The fluid heater shall be equipped with appropriate safety devices to prevent the occurrence of conditions which might damage the equipment or create an unsafe condition. A flame detection circuit, air flow monitor, fluid flow switch, exhaust spark arrester, and device to prevent unburned fuel accumulation are required.

3.5.18 The heater shall be completely enclosed within the vehicle shroud. Appropriate shielding shall be provided for the combustion chamber.

3.6 Controls & Instrumentations:

3.6.1 An operator's control panel shall be located on the exterior left side (looking forward) of the vehicle.

3.6.2 A fluid pressure gauge shall be provided giving pump pressure for deicing fluid.

3.6.3 A temperature gauge shall be provided for the deicing fluid tank.

3.6.4 Heater "on-off" controls and function monitoring lights shall be installed.

3.6.5 The following auxiliary engine equipment is required on the operator's control panel.

a) Hourmeter
b) Tachometer
c) Voltmeter
d) Ammeter
e) Ignition, starter, stop and cold start switches
f) Idle and high speed switch or hand throttle
g) Oil pressure gauge (and override switch if required)
h) Engine temperature gauge

3.6.6 An hourmeter for the heater shall be provided.

3.6.7 Sprayer manufacturer's standard controls and instrumentation shall also be installed on the operator's control panel.

3.6.8 Tank fluid level gauge readout is required. Gauge shall be visible when filling tank.

3.6.9 Permanent, non-fading placards, or pictograms per ARP 1838, shall be provided for all operating controls, instruments, fluid filling points, electrical switches, caution signs, and operating instructions.

3.7 Vehicle Body Description:

3.7.1 All major components, other than the aerial boom, shall be enclosed in a compartmentized body (shroud) meeting recognized appearance and functional standards of the truck body industry.

3.7.2 The shroud shall cover tank(s), auxiliary engine and other major components and have the external appearance of one continuous enclosure.

3.7.3 The top surface of the shroud(s) must be strong enough to support a 113.4 kg (250 lb) person, even if it is not to be used as a platform.

3.7.4 Access must be provided for servicing and changing components. Flush mounted panel doors and latches are preferred.

3.7.5 All exposed edges (corners) of the body should be radiused in accordance with standard manufacturing practices recognized in the automotive truck industry.

3.7.6 Walkways and ladders provided on the body for operational access to boom or tank shall conform to national safety standards.

3.8 Protective Equipment and Safety Devices:

3.8.1 An emergency auxiliary engine shut-down control shall be provided which is readily accessible from the driver's position.

3.8.2 All steps and platforms shall have a non-skid self-draining surface.

3.8.3 On vehicles not equipped with integral fire extinguishers, a small, lightly spring loaded, inward opening door shall be provided into the heater compartment to permit insertion of a fire extinguisher nozzle in an emergency.

3.8.4 The vehicle shall be equipped with devices to automatically shut down systems when a hazardous or self-destruction condition arises while the fluid pumping or heating systems are operating, but still allow the vehicle to be driven away from the aircraft.

3.8.5 Fluid heater and engines shall produce no noticeable smoke under normal operating conditions. Fumes shall not be evident 4.57 m (15 ft) downstream from exhaust outlets in still air.

3.8.6 Two weatherproof sealed beam floodlights on universal mounts and with control switch shall be permanently installed on the basket for night operations. These floodlights shall be readily available for adjustment by the operator while in the basket.

3.8.7 A light and "on-off" switch shall be installed to illuminate the auxiliary engine and fluid system compartment(s).

3.8.8 Combustion heaters that are equipped with hydraulic motor driven blowers shall include temperature and pressure compensated flow controls to provide constant speed control.

3.9 Optional Equipment:

3.9.1 If Type II thickened de-icing fluids are scheduled to be used, special design requirements must be met to avoid degrading the fluid by excessive agitation and heat. Temperature controls shall be installed to prevent Type II fluids being heated in excess of 60°C (140°F).

NOTE: Valuable information on Type II fluid requirements can be found in the A.E.A. Specifications.

3.9.2 A fluid tank electric immersion heater shall be installed to heat the deicing fluid prior to aircraft spraying operations. The heater shall consist of immersion elements located near the tank bottom below the fluid suction line port, and spaced to provide an even heat distribution in the tank. Appropriate protective and safety devices shall be fitted. A thermostat shall be installed with a sensing probe located near the fluid suction line port. The thermostat shall be enclosed, adjustable, and control at any set point between 60°C and 193°C (140°F and 200°F) with +1°C (2°F) accuracy. The ground power input shall be 208/240V, 60Hz, 3 phase supply, via a 4.57 m (15 ft) cable permanently attached and stored in a compartment near the rear of the vehicle. A properly sized fusible disconnect switch or circuit breaker (waterproof and weatherproof approved) shall be installed near the cable. The connecting plug on the cable shall be watertight with bushing and cable grip.

NOTE: The ground power input in many countries is 50Hz - 3 phase.

3.9.3 In lieu of pre-mixed deicing fluid operation from one tank, a valving arrangement shall be installed that selects and proportions the flow from a water and glycol tank to produce a variable glycol mix from 0% to 75% glycol. Controls for the valving shall be at the basket and at the control panel. A proportioned mix system shall have an accuracy of ±2% glycol content. A proportion indicator shall be mounted in the basket. All other fluid system requirements stated herein shall be included.

3.9.4 A temperature probe with a remote reading gauge shall be installed in a protected position downstream of the heater in the fluid delivery line.

3.9.5 Block heaters for cold weather starting shall be installed on both propulsion and auxiliary engines. They shall be 110V or 220V A.C. and have a common plug.

3.9.6 Meter(s) shall be installed with separate digital readouts in the cab for indicating the following:

- total liters (gallons) deicing fluid used (non-resettable)
- liters (gallons), glycol mix only used (resettable) - dual tank system only
- liters (gallons), water only used (resettable) - dual tank system only

The meter(s) shall be protected by a system pressure damper(s). The readouts shall be illuminated and at least 3.2 mm (0.125 in) size characters.

3.9.7 In lieu of an auxiliary engine, the vehicle propulsion engine shall be fitted with a hydrostatic gearbox designed to drive all the auxiliary components.

3.9.8 Both engines shall be fitted with cold weather starting systems.

3.9.9 An integral dry chemical or nitrogen fire extinguisher system shall be specified which, by automatically tripping, will cause auxiliary engine shut-down. Manual activation is also required.

3.9.10 Audible and visual warning in cab when approaching a low tank level condition indicating approximately 2 minutes of basket spraying remain shall be provided.

3.9.11 The heater identification plate shall state the actual BTU/hour heat output of the heater with the normal fuel consumption figure. Fuel used must be specified.

3.9.12 Protective devices on truck and auxiliary engines shall be fitted as follows:

a) Engine coolant low level engine kill switch with reset.

b) Low oil pressure engine kill switch with reset.

c) Engine coolant over-temperature engine kill switch with reset.

d) Vacuum kill switch in the suction side of the fluid pump(s) to prevent catastrophic pump failure.

NOTE: Indicator lights can be fitted to the control panel to show when a), b), c) or d) has been the cause of a shutdown.

e) Starter cut-out circuit to prevent energizing the starter when engine is running with reset.

f) Spark arrester exhaust system.

3.9.13 In lieu of the standard truck cab/chassis specified, a custom-built chassis proposal would be considered providing the deicing unit had distinct advantages over conventional designs.

3.9.14 A windshield washer and washer fluid container with a capacity of approximately 20 litres (5 U.S. gal) shall be provided for the cab overhead observation window.

3.9.15 A speed control device shall be provided to prevent the operator exceeding 6 km/h (3.75 mph) when the boom is in the raised position.

3.9.16 The personnel basket capacity shall be at least 204.1 kg (450 lb) with a 1.22 m x 0.61 m (4 x 2 ft) floor area to accommodate two standby persons.

3.9.17 The basket operator shall have the means to shut down the auxiliary engine in the event of an emergency.

3.9.18 An emergency shut-off valve (90 deg turn) shall be installed immediately up-stream of flexible hose supplying the basket nozzle.

3.9.19 A reel shall be provided for the stowage of the ground hose. The hose shall be unreeled by pulling the spray nozzle. Reeling shall be accomplished through use of a spring loaded reel or hand-operated mechanism.

3.9.20 A separate detergent storage and delivery system shall be made available.

3.9.21 The provision of sufficient non-flammable, non-fluid absorbing insulating material on the tank exterior and plumbing line surfaces shall be provided so that temperature loss shall not exceed 1°C (1.8°F) per hour with a full tank at 95°C (203°F) in an ambient temperature of 0°C (32°F) - no wind.

3.9.22 In addition to fluid tank gravity fill port, a pressure fill line and valve shall be provided at a ground level location. This shall be 5 cm (2 in) size minimum and could be common with tank drain fittings. Adequate tank venting and overflow provision shall be provided for a quick filling rate of 750 LPM (200 gpm).

3.9.23 A fluid pressure gauge(s) shall be provided giving pressure of deicing fluid at the basket.

3.9.24 An intercommunications set shall be installed between the basket and the cab. The set shall be fitted with a press to talk feature in cab and a live speaker or a headset at the basket.

3.9.25 A VHF transceiver shall be installed for communication with the flight deck and ground control.

3.9.26 The hydraulic reservoir shall be fitted with an electric strip (or immersion) heater of the same voltage as the engine block heater in order to eliminate a hydraulic fluid warm up period.

4. ACCEPTANCE INSPECTION:

4.1 The vendor shall accomplish sufficient testing on his own to indicate that unit performance and design is in accordance with the provisions of this specification prior to notifying the buyer of equipment readiness for qualification tests and inspection.

4.2 The vendor will schedule an operational and functional demonstration of the equipment at his plant or at a mutually agreed upon site. Verification of each requirement listed in this specification shall be accomplished by inspection, review of analytical data, demonstration, test and review of test data, or a combination of these. Satisfactory compliance to the specification shall be determined by the buyer.

4.3 Physical and dimensional conformance to proposal drawings, appearance, finish, component accessibility, maintainability, and all other requirements readily visible to the observer shall be included in the category of Inspection.

4.4 Prime mover/transmission matching and similar characteristics requiring laboratory testing and analysis shall be delineated in technical usable formats and made available to the buyer. Certification of test data shall be provided when requested.