ESTIMATING, CONSULTING, & INVESTIGATION

4397 Bedford Avenue, Brooklyn, NY 11229
Office (718) 891-4018, Fax (718) 646-2733, Cell (917) 860-3588
www.PnLEstimology.com
info@.PnLEstimology.com

ALUMINUM REPAIR IN THE AUTOMOTIVE COLLISION REPAIR INDUSTRY

A Study for the Aluminum Association, Inc

4397 Bedford Avenue, Brooklyn, NY 11229
Office (718) 891-4018, Fax (718) 646-2733, Cell (917) 860-3588
www.PnLEstimology.com
info@.PnLEstimology.com

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4397 Bedford Avenue, Brooklyn, NY 11229
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1.0 Introduction

Globally, automakers are focused on addressing consumer and regulatory demands for cars and trucks that are safer, greener and more energy efficient. As automakers work toward meeting current CO_2 and fuel economy targets of 54.5 mpg for the 2025 model year, mass reduction is a key strategy employed to achieve demands. As a result, aluminum-intensive vehicle (AIV) bodies and multi-material vehicles (MMV) with bodies containing aluminum, high-strength steel, composites and other materials are entering the market at record pace. This shift away from mono-material vehicle construction to a multi-material approach poses new challenges for the collision repair industry.

Aluminum is not new to the repair industry. The transition to high-volume vehicles with high aluminum content has been underway for more than 15 years. The first deviation from the aluminum-intensive sport performance vehicle was the mass-produced 1994 Audi A8 with Audi Space Frame (ASF). Today, MMVs and AIVs represent an increased share of new vehicle sales.

The rapid adoption of aluminum content body panels and structures on high-volume vehicles, such as the Ford F-150, requires the repair industry to respond quickly with expanded facility capabilities and technician training. A similar challenge occurred in 1979, when automakers began producing vehicles with monocoque body construction and only a small percentage of facilities had the knowledge and training required to conduct repair. A similar transition is occurring today with aluminum body construction.

The repair industry is committed to providing consumers with high quality, cost-effective collision repair services no matter the material. This report summarizes market adaptions underway within collision repair facilities to carryout AIV and MMV body repair procedures safely and reliably. Detailed in this report are the capital investments required to achieve proper vehicle repair, including equipment, technician training and certification, and facility modifications. Examined throughout are current cost differences in the repair of conventional steel body vehicles in contrast to AIV / MMV body construction.

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Data presented in this report was compiled from surveys of over 50 repair shops across the United States and responses captured confirm the following:

- Major cost differences between a steel and aluminum repair facility can be attributed to facility modifications or new building construction, welding equipment and riveting equipment;
- Technician training costs for aluminum and steel are similar;
- Welding certification costs for aluminum are marginally higher than the costs for steel; and
- Structural repair equipment required for a steel vehicle is identical to the equipment required for aluminum vehicles and cost the same.

The survey group includes both small and large multi-site independent repair collision facilities and original equipment manufacturer (OEM) dealerships.

2.0 OEM Collision Repair Certification

Proper collision repair practices are necessary to maintain original vehicle reliability and safety. Most OEMs require collision repair facilities go through rigorous Certified Collision Repair Facility (CCRF) training programs to receive certification as an authorized OEM repair facility for steel and aluminum vehicles. All programs require general training and tailored, model-specific collision repair curriculum for technicians. The CCRF program system is well supported by highly respected independent collision technician training and certification organizations, such as I-CAR. Most OEM programs require I-CAR training, while some require a facility maintain I-CAR Gold Class designation or Automotive Service Excellence (ASE) certification for each technician on the roster.

CCRF training requirements include general and specific repair training, as well as training in customer service, customer service indexing, uniform code and facility insurance requirements. Typically, CCRF programs require continuing education as new models and/or changes to models are introduced. Continuous re-certification in areas such welding, riveting and structural repairs are also required. While many requirements overlap between OEMs, each manufacturer requires certification to their own unique set of requirements.

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OEMs developed repair certification programs for four reasons:

1. Ensure adherence to OEM repair protocols and procedures for safe repairs;
2. Ensure technician knowledge and skills are sufficient to properly implement repair procedures;
3. Establish common repair standards for certified technicians; and
4. Ensure use of proper replacement components and materials for warranty coverage and, in many cases, to qualify a vehicle for Certified Pre-Owned (CPO) status.

Certification in aluminum repair typically requires a facility to have already obtained steel certification. An OEM dealer must sponsor entry into a CCRF program. Following evaluation and approval by a CCRF program manager, a facility may then pursue full aluminum certification.

Although it is likely that aluminum repair networks will continue to grow, the work that is funneled there is mainly structural because structural aluminum parts are generally only sold to network shops. Repairs on exterior panels (highest percentage of aluminum repairs) are being done in many out-of-network facilities.

3.0 Technician Investments

Through the CCRF program, the collision industry has a well-established system for training to OEM guidelines to achieve safe and reliable repair. Typically, the OEMs conduct their own model-specific training programs since most OEM's have at least one training location in the U.S. (a select few OEMs require technician travel to their Europe-based training centers). I-CAR also conducts certification training at multiple locations around the country and may host technicians for OEM-specific training at their Appleton, Wisconsin campus.

OEM CCRF technician training programs typically have the following requirements:

- Classroom instruction
- Online training
- Hands-on, instructor-led training (one OEM exception)

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- I-CAR general knowledge pre-requisite classes

CCRF technicians are often required to maintain current ASE Certification and I-CAR Platinum Level status. Many of the programs require yearly training, while others only require training once new models are released. All the programs require an understanding of the OE's repair procedures and protocols, meaning technicians require training and access to the OEM technical website. Investments in training and maintaining certifications reoccur annually.

Training costs for one OEM program can range from $1,125-$32,500, including travel. This is comparable for all OEM programs. Most body shops maintain one technician certified in aluminum repair for every vehicle brand the facility is certified to service.

Technician investment for training and CCIF for multiple OEM brands certification averages $65,000. Total investment in training and facility to achieve multi-brand CCRF status in an aluminum or steel program are comparable and range from $125,000-$250,000.

3.1 Metal Forming Processes

Most CCRF programs include a hands-on aluminum panel repair workshop. Technicians who will be repairing aluminum panels must have proper training to ensure an understanding of how the material moves when being heated. Shaping aluminum is different from shaping steel. Steel panels have a "memory" (elasticity) and have a tendency to return to its approximate original shape with cold working. Steel has good plasticity and elasticity ranges; conversely, aluminum has excellent plasticity ranges but limited elasticity range in automotive grade body and structural components. (Plasticity: the quality of being easily shaped or molded. Elasticity: the ability of a material to resume its original shape after being stretched or compressed.)

Aluminum frequently requires application of heat and more extensive mechanical working to return to original contours. Applications of forces to straighten aluminum may cause stress, which can cause ductile microfractures in the deformed areas.

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3.2 Welding Certification and Recertification

Almost all CCRF programs require I-CAR welder certification and an increasing number of OEM's require welder certification to ISO 9606-2 standards. The I-CAR Aluminum Welding Qualification Test (AWQT) is a general welding skills certification that is also a pre-requisite for most OEM welding certification tests. ISO 9606-2 "Fusion Welding of Aluminum," provides a set of rules for systematic qualification of welders, independent of product type, location and examiner or examining body. Most OEM's typically require initial certification testing of 40-80 hours at an OEM-certified welding training facility.

Once a technician passes the initial ISO certification test, they must recertify at intervals of 6-months to two years based upon OEM requirements. An exception is one OEM that has 5-year recertification requirements. Recertification generally involves two to four days of hands-on testing at an OEM-certified welding training facility. One exception is a sole OEM with a one-day recertification.

Costs for welding certification can range from $1,000-$3,500 for each test and is dependent on OEM testing requirements, training facility fees, transportation costs and technician compensation.

3.3 New Model Training and Recertification

CCRF programs generally require annual participation in a one to four day course to become familiar with new OEM models. This often requires the technician to take an online OEM introduction course, followed by a one to three day "on-vehicle" course onsite at an OEM training center. Most domestic OEMs utilize I-CAR for online courses taught by I-CAR instructors in a classroom lecture format that ranges from four to eight hours in length. Most OEMs also offer an opportunity for extensive hands-on training on new models under the guidance of an OEM trainer. Costs range from $50-$150 for online courses through I-CAR to several thousand dollars for OEM training center programs, not including travel expenses and technician salary. Total training costs increase with the number of OEM sponsored programs a facility pursues.

3.4 Training Cost Summary

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A properly equipped steel repair facility is on par with a properly equipped aluminum repair facility. However, one clear distinction exists—nearly all aluminum repair facilities start as a properly equipped and trained steel facility.

Repair Technician Training Costs

	Aluminum	**Steel**
I-CAR General		
Per Class	$123-$99	$123-$99
6 Classes	$738-$594*	$738-$594*
Metal Forming General		
I-CAR One Class	$123-$99	$123-$99
OEM	$300- $1,000	N/A
Welding I-CAR Certification (per test)**	$700 to $880	$700 to $880 *(Steel and Steel Structural)*
Welding Certification ISO	$3,500-$16,500	N/A
Recertification I-CAR	$700-$880	$700-$880
Recertification ISO	$1,500-$3,500	N/A
OEM New Model Training	$300-$1,500	$300-$1,500

Note travel, lodging, rental, expenses, salary and loss of production are not included in the above.

Key:

** = Minimum six I-CAR classes. Gold Class/Platinum Designation is $99 per class; regular price is $123 per class.*

*** = Travel not required, In-Shop Testing Gold Class/Platinum Designation is $700 per test; regular price is $880 per test.*

4.0 Facility Investments

Collision repair facilities must go through rigorous upgrades to receive certification as an authorized OEM aluminum repair facility. Facility requirements for CCRF programs are similar for steel and aluminum and include building accommodations, aluminum specific welders, hand tools, and alignment bench provisions for aluminum structures. Capital equipment investments for upgrades are minimal after initial investments.

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4.1 Clean Area/Clean Room

OEM CCRF programs include provisions to manage aluminum dust safely. During fabricating operations, aluminum fines may be generated by such activities as grinding, sawing, cutting, sanding or scratch brushing and at least some of them will be fine enough to be potentially explosive. Most CCRF programs require portable vacuum-air extraction systems with wet mix dust collection for use when grinding, sanding or welding to limit airborne aluminum dust particles and gases. Most OEMs also require “clean areas” for aluminum repair. Clean area requirements vary by OEM, ranging from sectioned-off areas with fire resistant curtains and spark proof ventilation to a fully equipped standalone “clean room.” Standalone clean rooms typically include fire resistant walls (three-sided), roof, curtain or roll-up door, spark proof extraction fan, grounded airlines, grounded and isolated lighting and electrical outlets, and other equipment for self-containment. Some OEMs that previously required curtained isolated clean areas now require a full clean room.

Clean Room Investment

	Curtain Isolated Area	Standalone Clean Room	Standalone Building
Clean Room Type	$8,000-$20,000	$40,000-$100,000	$40,000-$400,000
Portable Extraction	$4,000-$15,000	$4,000-$30,000	$4,000-$30,000

4.2 Welders

To achieve CCRF status for repair of steel vehicles, facilities are required to have a specific Squeeze Type Resistance Spot Welder (STRSW) with inverter technology, a Metal Active Gas (MAG)/Gas Metal Arc Welding (GMAW) machine, and a Silicone-Bronze Brazing Metal Inert Gas (MIG) welder.

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To secure CCRF aluminum designation, facilities must purchase an OEM-specified aluminum pulse welder. Depending on the number of aluminum CCRF programs the facility participates in, multiple aluminum pulse welders may be required to secure specific OEM approval(s).

Steel Vehicle Welding Tool Investments

Squeeze Type Resistance Spot Welder	$16,500-$26,000
Metal Active Gas/Gas Metal Arc Welding machine	$600-$3,000
Silicone-Bronze Brazing Metal Inert Gas (MIG) welder	$600-$8,000

AIV Welding Tool Investments

Aluminum Pulse Welder	$4,000-$20,000

4.3 Hand Tools

To avoid cross-contamination, CCRF programs typically require separate sets of general hand tools (ratchets, sockets, breaker bars, screwdrivers, pry bars and wrenches) for steel and aluminum repairs. If a facility chooses to use the same general hand tools on aluminum and steel repairs, tools must be wiped clean prior to each use. Separate air/electric power tools and cutting tools for sanding and grinding are also typically required.

CCRFs commonly invest in separate sets of general hand tools and air/electric power tools to ensure no cross-contamination. The cost of a single set of general hand tools to support aluminum repair is similar to those required to support steel repairs. Multiple sets may be required depending on facility need.

Specialty hand tools, such as specific duty wrenches, sockets and bit drivers along with alignment and adjustment tools specific to particular vehicle models, may also be required. Rivet guns are generally specific to an OEM application and can include a mix of rivet types, such as blind rivets, self-piercing rivets (SPRs) and solid rivets. Each OEM has tailored specifications and requirements for the type of rivet gun for use on their vehicles. Rivet guns are available in electric or pneumatic versions. Some guns are standalone for one type of rivet while other guns have interchangeable heads to handle varied rivet types. Repair facilities servicing multiple OEM brands may be required to purchase multiple guns, even if a rivet gun that can perform the task is already available.

Hand Tool Investment

	Aluminum	**Steel**
General Hand Tools (per set)	$ 2,000-$10,000	$ 2,000-$10,000
OEM Specified General Hand Tools (per set)	$ 5,000-$15,000	$ 5,000-$15,000
OEM Model Specific Tools (per model)	<$3,000	<$3,000
Rivet Guns (per gun)	$6,500-$15,000	$6,500-$15,000

4.4 Structural Repair Apparatus (SRA)

CCRF certification frequently requires purchase of new Structural Realignment Apparatus (SRA) equipment or an upgrade to existing equipment. An SRA is required for repair of both steel and aluminum vehicle body structures and has three primary uses:

1) Identify structural misalignment when estimating repair cost;
2) Straighten body structures with force (realignment); and
3) Maintain proper body geometry during structural component cut-remove-and-replace procedures.

SRAs can be permanently anchored to the shop floor or portable allowing the SRA to be rolled between aluminum and steel repair areas. Mobile SRAs require cleaning prior to leaving either area to ensure no cross-contamination.

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OEMs restrict the amount of structural realignment allowable for specific vehicles and damage assessors must identify any structural misalignment prior to starting a repair process. To support accurate structural damage assessment CCRFs are required to have dedicated fixture jigs, universal jigs and/or three-dimensional electronic measuring equipment to ensure proper diagnosis and documentation of each vehicle.

Structural Alignment Apparatus Cost

	Aluminum	**Steel**
Alignment Bench (per unit)	$25,000-$75,000	$25,000 - $75,000
3-D Measurement System	$20,000-$48,000	$20,000 - $48,000
Jigs/Fixtures -universal or rentable (per vehicle model)	Approx. $20,000	Approx. $20,000

4.5 Facility Certification

In most cases, a CCRF must have a relationship with a dealer of the OEM brand they seek certification with. Once a dealer sponsors a facility and the CCRF program manager approves, the facility receives its package of CCRF requirements. Many of the requirements may already be in place and only equipment, training and onsite inspections are needed. Some repair facilities are certified as CCRF with another OEM and the transition to become another OEM CCRF may be simple. For CCRF programs that do not require dealer sponsorship, equipment, training and onsite inspections are still required. CCRF aluminum facilities display “Authorized OEM Repair Facility” signage prominently and list their designation on the OEM CCRF website. All CCRF programs require monthly Customer Service Review Surveys.

5.0 Levels of Repair and Frequency

Due to cost considerations, more than 70 percent of all body repair jobs, whether steel or aluminum, involve removing the damaged panel and replacing with a new panel. Reparability of panels is dependent on the amount of sustained damage, location of the damage on the panel, and if any fractures occurred. Fender panels, door panels and roof panels offer opportunities for cost effective

4397 Bedford Avenue, Brooklyn, NY 11229
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repair of minor damage due to design and backside access. Repairs to quarter panels and rocker panels are less cost effective due to limited backside access, presence of foams between inner and outer panels, and adhesives utilized to attach outer panels to inner components.

Levels of Repair (% Frequency)

	% of Repairs
Closure - Minor Scratch, Dent	10-15
On Vehicle	90
Off Vehicle	10
Closure – remove and replace	85-90
Structural	10-15
Straighten	0
Cut and replace	10

5.1 Closure Panels – Cosmetic Scratches/Deformities

Cosmetic aluminum panel repair requires more metal forming and shaping skills than does a steel panel. Proper repair of aluminum panels typically involves maintaining the damaged area at an elevated temperature while working the metal. Maintaining proper panel working temperature may require two technicians: one “working out” the damage with hammer and dolly techniques, and weld-on-pins and levers, and the other maintaining working temperature with a torch and non-contact thermometer. Steel repair does not require application of heat; therefore, a two-technician process is generally not needed.

Hood panels and deck lids (trunks) that have sustained minor cosmetic damage, such as scratches and dents, are, in many cases, candidates for cost effective repair. Additional labor time may be required for component removal or, if needed, for trial fitting of the component. With full access to the backside, some aluminum components, such as door assemblies, are left on the vehicle during repair, but would require the removal of the glass, regulator and other interior components. In areas

4397 Bedford Avenue, Brooklyn, NY 11229
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inaccessible from the backside, paintless dent repair techniques are used. If the backside area is viewable and there are no foams or adhesives in the area, weld-on dent removal pins are utilized.

5.2 Closure Panels – Major Deformities

Hood panels, deck lids (trunks), doors and fenders that have sustained significant damage generally require replacement due to the design of the panels, restricted backside access, and crush initiators built into the components. It is generally not cost effective to attempt manual repair to these “bolt on” panels. Additionally, due to the forming and shaping process (work hardening) at the factory, the feature lines (bodylines) are generally thinner on the lines and as such, make repairs in these areas difficult or impossible.

5.3 Sanding, Filing and Panel Preparation for Filler

Procedures for sanding and preparing an aluminum panel for filler are not much different from the steps for a steel panel. After sanding, repaired aluminum panel areas must be brushed with a stainless steel wire brush prior to application of epoxy primer and/or aluminum body filler. Depending on the OEM procedure, general filler or OEM-specific aluminum filler is used. Epoxy primer is generally not required when applying aluminum body filler; however, most OEM’s require use of epoxy primer prior to application of general body filler.

5.4 Filler Application and Final Area Preparation for Primer

Applying body filler to an aluminum panel is no different than applying filler to a steel panel. The aluminum filler must be heated to a specific temperature, and for a specific amount of time, prior to application. Additional heat may be required for curing depending on the filler type used. After the filler is final, the area is primed and block sanded. This process is the same for steel or aluminum repairs. After the primer cures, primed areas are sanded and the painted areas are sanded at which point the panel would be ready for refinish preparation.

5.5 Structural Repair – Realignment vs. Cut, Remove, Replace

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Generally, structural realignment is not allowed for aluminum-bodied vehicles. However, some OEMs now allow limited structural realignment of aluminum-bodied vehicles that do not include structural castings. In these cases, limited structural realignment is allowed only in the indirect damaged areas. OEMs do not allow realignment of aluminum or steel structural areas with direct collision damage. Direct collision damage is repaired by removing the damaged area and replacing with OEM authorized field repair components using authorized procedures and protocols.

5.6 Cutting and Removal According to OEM Protocols (Full or Sectioning)

OEMs provide specific sectioning procedures and repair part kits to implement allowable body structural repairs. Many of the service components allow for removal of portions for sectioning. The left over component may be used in a different vehicle repair, where damage is in areas other than the removed portion.

5.7 Component Preparation for Rivet-Bond, Welding, FDS-Bond or Some Combination of the Aforementioned.

Each OEM has specific products and procedures required to prepare aluminum surfaces for attachments. Mating flanges need to be cleaned to bare aluminum. This is typically accomplished with an abrasive pad that will remove only the paint coatings and not reduce the thickness of the aluminum. Rivet holes, if present, need to be drilled, deburred and cleaned. Bare mating flanges are treated by one of several procedures, including the following:

- Open flame;
- Liquid chemical sanded into the bare aluminum areas; or
- A special stone sanded into the bare aluminum.

Following surface preparation adhesive is applied according to OEM-specific procedures and using OEM-specified applicator guns. Most procedures require a bead on both flanges to be spread out to cover all of the bare metal and a third bead to maintain bond-line thickness.

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It is important to note that a large percentage of steel vehicles have aluminum hood panels, some steel vehicles have aluminum door assemblies, and a select few have aluminum decklids. As such, the percentage of aluminum closure panel repair revenue is higher than if the numbers were based on just aluminum-intensive vehicles. If the damage were repairable, 90 percent of those repairs would be while the component was affixed to the vehicle. Most of the damage to closure and outer panels are replaced due to a variety of reasons, as aforementioned. As far as the percentages for structural repair, many of the repair facilities claim a large portion of the structural repairs involve quarter panels, rear body panels and front lower rail extensions.

5.8 Repair Facility Standard Operating Procedures

Aluminum repair facilities have different Standard Operating Procedures (SOPs) than steel facilities. OEMs have similar SOPs, but these SOPs also add overhead and operational costs, resulting in aluminum repair costs to be slightly higher than steel reapers. Generally, SOPs that must be adhered are as follows:

Conversely, there are situations where facilities need to work on a steel/aluminum hybrid design or vehicles with both aluminum and steel components. For example, structural repair on a 2015 Ford F-150 may require repairs to the steel frame and the aluminum upper body. The facility would need to take extra care to cover the aluminum equipment and bench along with covering the aluminum components while working on the steel portions and vice versa. After repairs on those portions, the facility will need to vacuum the repair area and all adjacent areas. Additionally, a vacuum extractor is needed when drilling, sanding, cutting or grinding. All tools need to be cleaned before and after use to ensure no cross-contamination. No compressed air cleaning (blowing off) of components or equipment should be attempted in the aluminum repair area.

Steel/aluminum hybrid construction vehicles pose a slightly different set of procedures. Although care is needed when working on aluminum, extra care is required when working on vehicles with direct aluminum to steel contact. Examples of steel/aluminum hybrid vehicles are the 2015 Mercedes-Benz S Class, which has a steel rear quarter panel attached to an aluminum rear body panel and rear floor

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extension, and the 2015 Audi TT with direct attachment of steel to aluminum components in the rear area. When OEM's have aluminum and steel components affixed to each other adhesive is used to prevent cross-contamination, but when cutting, drilling and sanding particles of steel and aluminum will become airborne and those particles must be vacuumed up. All adjacent areas must be covered to prevent galvanic corrosion from forming.

6.0 Operating Cost

Direct labor is the largest cost line item in the collision repair industry. Costs for an individual repair are based on the time required to complete a proper quality repair in addition to repair technician's wages. Additional costs that must be factored in are tooling, capital equipment, continued training, upgrades for new models/material, rate of inflation and return on investment.

6.1 Labor Time Differences Between Steel and Aluminum

Time-to-repair for the aluminum panel is influenced by a few key factors: location of the damage, body feature lines, accessibility and severity of sustained damage. More than 70 percent of all repair incidences involve damaged panels being removed and replaced with new panels. Time required removing and replacing aluminum panels is similar to the time required to do the same with steel panels.

Damage on feature lines of aluminum panels are difficult to restore to their shape due to the extreme work hardening placed on the lines, which will cause thinning of the aluminum in these areas. During repair, damage to feature lines are susceptible to fracturing. Due to deformation characteristics of aluminum, it is generally more time consuming to work a curved aluminum panel back to original shape than to work a comparable steel panel back to original shape. Where panel straightening is involved, on average it can take about 20-40 percent longer to repair an aluminum panel that a similar steel panel.

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6.2 Labor Rates

Prevailing labor rates for aluminum are two to four times higher than for steel. The main reasons for higher labor rates for aluminum repairs are equipment costs and additional technician training coupled with a relatively small number of repair incidents. Although costs to become certified in aluminum body repair are comparable to costs associated with steel repair, collision repair of AIVs is currently less than 1 percent of total collision repair incidences. As a result, facility investments in equipment and technician training for aluminum repair certification are underutilized. Repair facilities must amortize aluminum-specific equipment investments and training over a narrow spread of infrequent aluminum repair incidences. Aluminum repair labor rates are expected to be comparable to steel rates as AIV penetration increases in market share.

Collision Repair Labor Rates ($/Hr.)

	Steel	Aluminum
Refinishing	$42-$65	$85-$100
Body Repair	$42-$65	$100-$175
Structural	$42-$75	$125-$200

6.3 Percentage of Total Repair Revenue

Aluminum CCRFs indicate AIV repair accounts for 10-40 percent of total shop revenue aluminum.

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Levels of Repair (% Frequency vs. % Facility Revenue)

	% of Repairs	% Repair Revenue
Closure - Minor Scratch, Dent	10-15	20
On Vehicle	90	30-35
Off Vehicle	10	5
Closure – remove and replace	85-90	45-50
Structural	10-15	15
Straighten	0	0
Cut and replace	10	15

7.0 Conclusion

Collision repair of AIVs and MMVs is not more difficult than traditional steel-bodied vehicles. However, it is very different requiring technicians to also think differently. Bumpers, hoods and decklids (trunks) made of aluminum are repaired by most body shops today, and there are many of aluminum-bodied vehicles on the road that are regularly repaired as needed. In the next five to ten years we will see more aluminum closure panels and bolt on structural components, along with more and more OEM's producing hybrid construction designs. Nearly a dozen high-volume aluminum-intensive and hybrid construction vehicles are also expected in the next three to five years.

As more high-volume vehicles convert to aluminum, repair facilities must expand their repair techniques and philosophies to ensure technicians are well prepared. This market transition will require technicians to learn new repair procedures and become knowledgeable in the use of new tools and equipment. Ultimately, the need for education, certification and technician training will continue to increase. With the industry professionals at I-CAR on the frontlines, ongoing collaboration will ensure repair facilities are armed with the tools and skills required for safe and reliable repair as automakers continue to reach new limits.