

NSX**BODY****DESIGN**
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Like every mechanical aspect of the NSX, the exterior styling had to embody the Honda spirit. Additionally, it had to visually transmit the car's performance capabilities, high technology aspirations and a refined but aggressive nature. From every angle the car had to display a lean, muscular appearance. From the front and rear, the designers felt it crucial that it have a wide, solid stance. These are categorized as the intangible goals—the purely emotional responses to the car's shape. But before settling on the final design, a number of concrete goals were also established.

OVERVIEW
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The basic theme of the the NSX is that of a long-tail, cabin forward design. Locating the visual mass of the greenhouse far forward on the body not only accomplishes the goal of giving the NSX a sleek, aggressive look, it also contributes to the purely functional aspects of the car. The forward cabin location optimizes visibility while the long-tail design enhances high speed directional stability. The long tail also provides adequate space to package the drivetrain and trunk. A wide front and rear track complemented visually with sculptured front and rear fenders, give the NSX a muscular look.

NSX**BODY****FUNCTION AND FORM**
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One prime consideration was excellent all-around visibility. Poor rear and rear-three-quarter visibility have traditionally been a hallmark of most exotics and the prevailing attitude was that lack of rear visibility is the inevitable price one pays for the advantages of a midship engine placement. Honda saw this shortcoming as unacceptable. Visibility out the front is, obviously, an even greater concern and the designers saw a low cowl height as a key element in the final shape of the NSX.

Good aerodynamics was also an important consideration for high speed stability, low wind noise, and improved fuel economy. Finally, the exterior designers had to provide an envelope large enough to accommodate not just all the mechanical components, but provide a roomy trunk, and ample interior space for the driver and passenger. Furthermore, the space for occupants had to be properly proportioned and correctly oriented. They wanted to avoid at all costs the uncomfortable offset pedal and steering wheel arrangement common to many exotics. The pedals, wheel, and seat had to be located in a way that was ergonomically correct and one that felt "natural" to the driver. While this might be considered a task for the interior designers, it's patently evident that too narrow an exterior front section, would make the interior designers' job impossible.

The task of the exterior designers was to juggle all these elements, some of which were in direct conflict, and create a harmonious, organic shape.

Thematically, the F16 came into play here just as it did in establishing the conceptual goals of the NSX. In the F16, and other high performance craft such as Unlimited Hydroplanes, single seat race cars, etc., the control center, or cockpit, is located far forward on the body, well in front of the power unit. This design is a natural outgrowth of the function of the craft. The driver, or pilot, needs to see as much of his environment as possible—whether slicing through the sky at Mach II or aiming for an apex at 150 mph.

NSX

BODY

The cabin-forward theme seemed proper and natural for the NSX. It performed the aesthetic function of making the car look purposeful and powerful and evoked the image of a high performance craft. It also performed the practical functions of putting the landscape right in the driver's lap where it belongs and allowing the packaging space for the engine, drivetrain and fuel tank.

A natural adjunct of the cabin forward arrangement is the shape of the greenhouse proper. A number of themes were explored and the shape that emerged as the most graceful and flowing was the evocation of a fighter's canopy. This particular shape lent itself naturally into a sloping hood and fender line, which, when coupled to the low cowl height offered the bold look and forward visibility benefit the designers were pursuing. The canopy-shaped greenhouse also provides excellent rear and rear-three-quarter visibility.

Another theme they explored was that of a jet fighter pilot's helmet. They wanted to give the driver the impression that he was actually out in the windstream. To execute this ambiance for the driver required merging exterior styling and interior details which will be detailed later in the Ergonomics discussion.

Once this canopy theme was established, the designers explored a number of body themes in order to find a shape that best telegraphed the car's personality. They felt that a clean, sweeping line from nose to tail, one that rose gradually to meet the rear spoiler was in keeping with the car's personality and its philosophical reason for being.

The final form is a successful integration of all the various elements with which the designers had been grappling. Firstly, to emphasize the fighter canopy look, the A- and B-pillars and the roof would not be painted in body colors, but rather be painted black. This marks a clear separation between the body and the greenhouse creating the impression of a light and airy upper and a strong, aggressive lower body. Another visual cue that further enhances the separation between greenhouse and body is the design of

NSX

BODY

the door handles which have been fitted to the leading edge of the B-pillar and also painted black. This detail creates a clean door panel and enhances the uninterrupted visual flow of the body line. The idea was not to trip up or catch the eye as it swept from front to rear.

Wheel openings were designed to be just large enough to accommodate the wheel and tire practically. This minimizes the clearance between body and wheel which maintains a tight, uncluttered look and also helps airflow management. The wheel design itself is simple and purposeful. Five fairly broad spokes with clean radiused surfaces enhance the sporty image. From a straight-on front or rear view, the wheels are practically on the same plane as the body sides and contribute to the wide stance and aggressive look.

At the rear the design of the spoiler was integrated into the quarter panels. The panels rise sharply at a point just past the end of the rear wheels and fold into a single sweeping line to merge into the rear spoiler. The center high mounted stop light was designed into the trailing edge of the spoiler in order to maintain a unified, integrated look.

The most visually striking aspect of the NSX is the long-tail design. This gives the car a long, lean look. The long tail and integral spoiler contribute significantly to high speed directional stability. The long tail also provides ample space to package the mechanical components.

The area below the rear bumper is evocative of the Formula One underbody tunnels which help to evacuate air from under the car at speed and help to create downforce.

The leading edges of the functional side air intakes were brought far forward on the body all the way to the leading edges of the doors. This detail emphasizes the fact that this is a mid-engine car and helps contribute to the overall long look of the body.

NSX**BODY**

At the front, the turn signal/parking light units were designed to wrap around to the side of the fenders. They terminate on the same vertical plane as the inside edge of the headlight covers. Also, to help tie the retractable lights and the parking lights visually, the parking light opening has a sharp bevel design, similar to the bevel designed into the lower leading edge of the headlight opening. This bevel theme is also echoed in the large hood notch which serves to increase the driver's lower sight line and to emphasize the strong, muscular appearance of the fenders.

Three air intake openings were designed into the front cap. The large central opening for radiator cooling is divided horizontally by a single, thin airfoil section which visually has the effect of reducing the size of the opening maintaining the proportions of the opening relative to the front end. The openings on either side are designed to terminate on the same plane as the inside edge of the headlight cover and the inside edge of the parking light unit. This again visually ties all three elements together. Below the front bumper, a black chin spoiler was designed for aerodynamic improvements.

AERODYNAMICS

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Aerodynamic development began at the same time final surface development was underway. Aero testing was first conducted using one-fifth scale models. This was done in an effort to validate overall shape and conceptual themes. Final testing was conducted with full-size cars at the JARI (Japan Automotive Research Institute) wind tunnel in Japan and at the DNW wind tunnel in the Netherlands with all final specification equipment installed (European or U.S. spec license plates, lights, air conditioning condensers etc.).

The initial target was to refine the surface detail in order to produce a Cd of less than 0.33, a Cl near zero, and a coefficient of yaw moment of 0.25 at a 30 Deg. angle of attack relative to the car's centerline. As a high performance car, the aerodynamicists perceived lift and yaw moment just as crucial as a low Cd. The ultimate goal was to achieve a balance of Drag, Lift and Yaw forces and create a car which was stable at speeds under a variety of wind conditions.

From the very beginning of aerodynamic testing it was found that the cabin forward arrangement was well suited for overall aerodynamic efficiency. The long tail, short front design was found to be ideal for enhancing high speed directional stability and maintaining laminar airflow.

Starting with this aerodynamically sound envelope the engineers set about refining and optimizing the surface. To improve downforce at the rear, the design of the integral spoiler was developed to enhance high speed stability, reduce the yaw moment, achieve neutral lift and eliminate turbulence.

During wind tunnel development, seven crucial areas were optimized to create the balance of aerodynamic forces the engineers had targeted. These were the taper

NSX

BODY

angle of the front end, the front end section height and shape, the area under the front bumper, the taper angle of the rear section, the angle of the rear glass, the length of the tail and rear overhang and the height and angle of attack of the rear spoiler.

Part of the original design of the car was to provide ample leg room and eliminate the offset driving position mentioned earlier. To do this required a front end which doesn't taper to a sharply pointed nose, but rather a nose whose width remains fairly constant from A-pillar to bumper. An empirical evaluation might lead one to the conclusion that this would impact adversely on good air penetration at speed. Interestingly enough, the wind tunnel indicated quite the contrary. Despite the fairly wide front end, for an exotic, the Cd didn't suffer at all from this condition. As a result, the NSX is able to provide the driver and passenger with natural seating positions and still maintain good aerodynamic characteristics.

The area under the hood has been left open at the bottom in order to provide maximum cooling airflow for the radiator. Ambient air is ducted through the grille, passes through the radiator and is then allowed to escape underneath the car. The air intake ducts for the air conditioning condensers, mounted low inside the front fenders, were optimized for maximum air flow and minimum aerodynamic drag.

The under body area was also smoothed for better air flow and reduced turbulence. The bottom of the central tunnel has been enclosed with a plastic cover and many components have been tucked up out of the airstream.

To further improve laminar airflow and reduce wind noise, the NSX features virtually flush mounted glass with only a 4mm distance between the glass and surrounding frame. The net result of the aerodynamic development project is a final Cl of 0.05, a Cd of 0.32, a yaw moment of 0.24 @ 30 Deg., and CdxA of 0.57. The frontal area measures a compact 1.78 square meters.

STRUCTURE

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A rigid structure is of paramount importance in a performance car. High rigidity provides a stable platform for proper suspension geometry and alignment, and it makes possible a tight, rattle free interior. A structure that flexes under torsional or bending loads will upset the suspension geometry causing unwanted toe-change, steering deflection and a host of handling problems.

Additionally, central to the goal of performance is a favorable power to weight ratio. It's obvious that a heavy car needs a lot of power to achieve high levels of performance. Conversely, a very light car can achieve the same performance levels with less horsepower. With that goal in mind, several research projects were launched.

This project examined virtually every material to determine its feasibility for a light weight unit-body chassis. The materials examined included steel, aluminum, carbon fiber, sheet molded plastic, fiberglass, and many other forms of plastic. They were examined for strength, rigidity, weight, flammability, formability, cost and of course, availability in the quantities necessary for production.

The result of this investigation lead the project team to the conclusion that aluminum was the ideal material for this application.

Although aluminum is roughly one-third the weight of steel, it's less rigid. It also costs 5 to 6 times more than steel. Thus the major challenge was how to exploit the weight advantage of aluminum while overcoming all the other disadvantages.

Aluminum, for instance, isn't as malleable as steel and is therefore much more difficult to form into the hundreds of complex shapes necessary to create a car's structure. In a stamping operation, aluminum tends to tear, while steel bends and forms

NSX**BODY**

more easily into shape. Also, the surface finish of aluminum stampings is rougher than steel. If paint is applied to this rough surface, it produces less than satisfactory results. While this cosmetic consideration is irrelevant when dealing with the under-structure, it becomes extremely important when stamping the exterior body panels. The solution was found by using specially polished dies. Although these dies required the highest quality control procedures they provided the flawless surface finish the engineers had targeted for the Acura NSX.

Since aluminum conducts and dissipates heat more quickly than steel, the simple act of welding emerged as a challenge to the manufacturing engineers. They knew conventional spot welding equipment designed for steel, couldn't deliver the necessary high current and produce the desired clamping pressure needed to properly weld aluminum. It takes 3 to 4 times the current and 2 to 3 times the pressure compared to steel. New, larger, more powerful spot welders had to be designed that were capable of applying sufficient force and delivering enough current to do the job.

This new welding equipment performs 90% of the welding operations on the NSX assembly line. The rest is done by hand using arc, TIG and MIG welding techniques. As will be explained in the Manufacturing section, each assembly operation at the plant is also a quality inspection station.

The biggest problem to overcome, by far, was how to create a lightweight aluminum chassis with the rigidity of steel. The engineers' primary ally in this quest was the Cray supercomputer. With it, they were able to perform the vast number of Finite Element Modelling and stress analysis calculations necessary to optimize the original concept. To begin with, all the existing software, which was programmed for the torsional and bending values of steel, had to be re-written for the properties of aluminum. The R&D staff conducted extensive investigations of eight different aluminum alloys. They were analyzed for mechanical properties such as bending and tensile strength, formability, weldability and corrosion resistance. When this

NSX**BODY**

investigation was completed, the goal of building an aluminum chassis came within reach. They had a fairly accurate picture of which alloy and in what thickness would best work in any given area of the structure. In a sense, this was like solving an enormous jigsaw puzzle.

The unit body utilizes a number of different alloys for different applications. The structural sections are made of HA5182P-O. This is a non-heat-treated 5000 series alloy which provides excellent corrosion resistance, good weldability and excellent malleability. The exterior body panels are made of three different 6000 series alloys. These alloys are particularly resistant to corrosion. They're also heat treated to provide excellent resistance to minor denting. The exterior panels are 40% thicker than comparable panels made of steel.

When the actual design work began on the Cray, the chassis was analyzed for torsional and bending stresses in an effort to determine what grade of alloy and in what thickness could best do the job for each particular area. To establish a baseline for comparison, virtually every leading competitor was subjected to torsional and bending forces, in both real world driving and on test fixtures, and measured for resultant deflection.

Use of the Cray contributed to a number of design innovations. In some areas, conventional stamping was inefficient in meeting the high rigidity targets. One key area was the side sill, or rocker panel. This section of the chassis ties together the front and rear sections of the body and contributes the most to bending rigidity. Instead of stamping, a large hollow-section aluminum extrusion is used. This light extrusion has an internal web which imparts enormous rigidity. This extrusion not only contributes significantly to bending rigidity but also contributes to occupant protection in case of a side impact.

NSX**BODY**

The bumper beam is used as both the mounting base for the bumper and also as a structural element which ties together the front frame rails helping to resist torsional distortion. This unit is in fact the front portion of a four-sided box structure which is composed of the two front rails and the forward bulkhead. The front structural rails are straight-sided rectangular sections which are tied to the bulkhead. A similar bumper beam at the rear ties together the rear frame rails and provides resistance to torsional loads. Additionally, the rear frame rails not only tie into the rear bulkhead but also into a large cross-section frame which contributes to overall rigidity.

The A-pillar, while thin in cross-section for greater forward visibility, was optimized for strength and with the windshield header, roof beams and B-pillars, forms a rigid, triangulated structure which will maintain the integrity of the greenhouse. The B-Pillar was reinforced at the base by flaring the inside section where it ties into the main frame rails.

The only significant element in the chassis not made of aluminum is a steel tube section that runs across the width of the car just under the dashboard. This unit was designed as a mounting platform for the steering column.

By the end of this testing process, four prototype chassis had been built before all the rigidity, impact resistance, sound resonance, formability, and paintability targets were achieved. The result of all this research and development effort is a chassis that weighs 210 kg. (462 lbs.) with doors, hood and deck lids installed — about 40% less than a steel chassis — but has excellent rigidity and impact protection. It's also significantly stiffer than every other competitor currently on the market.

NSX**BODY**

ANTI-CORROSION PROTECTION

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Although aluminum doesn't rust like steel, it's still subject to environmental corrosion. It's also subject to galvanic corrosion when it's mated to a dissimilar metal such as steel. To prevent environmental corrosion, the bodies receive a chromate coating similar to the process used in the aircraft industry. Conventional electro-deposition of primer is then applied over the chromate. This is followed by a base coat of paint, and three top coats.

To prevent galvanic corrosion, all the steel components, such as brackets, bolts, and washers, are Dacro coated to prevent the inherent induction current produced when different metals are joined. The steel bolts can be removed and re-installed up to ten times before significant deterioration of the protective coating occurs.

INJECTION MOLDED INTEGRATED BUMPER SURFACES

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The specifications for the front and rear integrated bumper surfaces called for very high paint gloss standards, high bending elasticity to be able to withstand a 5 mph impact without damage, and high resistance to weather and environmental deterioration. The solution was an injection-molded one-piece bumper assembly.

NSX**BODY****PROJECTOR BEAM HEADLAMPS**
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The use of projector beam headlamps accomplishes three crucial goals. One, is to provide the driver with the brightest possible forward lighting and optimum light distribution. Secondly, projector beams provide a compact package that can be easily integrated into the NSX's compact front dimensions. And thirdly, when raised, they offer the least aerodynamic turbulence compared to conventional headlamps. Each of the four headlamps consists of a bulb, a glass lens to focus the beam, and a conventional external lens cover to provide the correct light distribution left and right. The overall exterior dimensions are 90 mm high by 200 mm wide. The size could actually be reduced to 60 mm high without any loss in light output, but U.S. requirements for headlamp height compel the use of a 90 mm lamp.

PIN GUIDE SASHLESS DOOR & ALUMINUM DOOR GLASS REGULATOR
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In order to reduce wind leakage and its attendant wind noise, a guide pin is installed in the door above the beltline. The guide pin positions the highly curved side glass and helps to hold it firmly in position against the weathersealed door opening.

To save weight, an aluminum, U-shaped single channel, cable-type regulator was utilized for window operation.

NSX**BODY****LIGHTWEIGHT LAMINATED WINDSHIELD**
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In order to reduce the weight of the windshield and further lower overall body weight, a thinner laminated glass panel was used for the windshield. The standard dimensions for inner and outer glass are 2.0 mm each. The NSX windshield uses a 2.0 mm outer panel and a 1.8 mm inner panel. This helps retain toughness but saves 0.62 kg. (1.36 lb.).

SOUND DEADENING REAR GLASS
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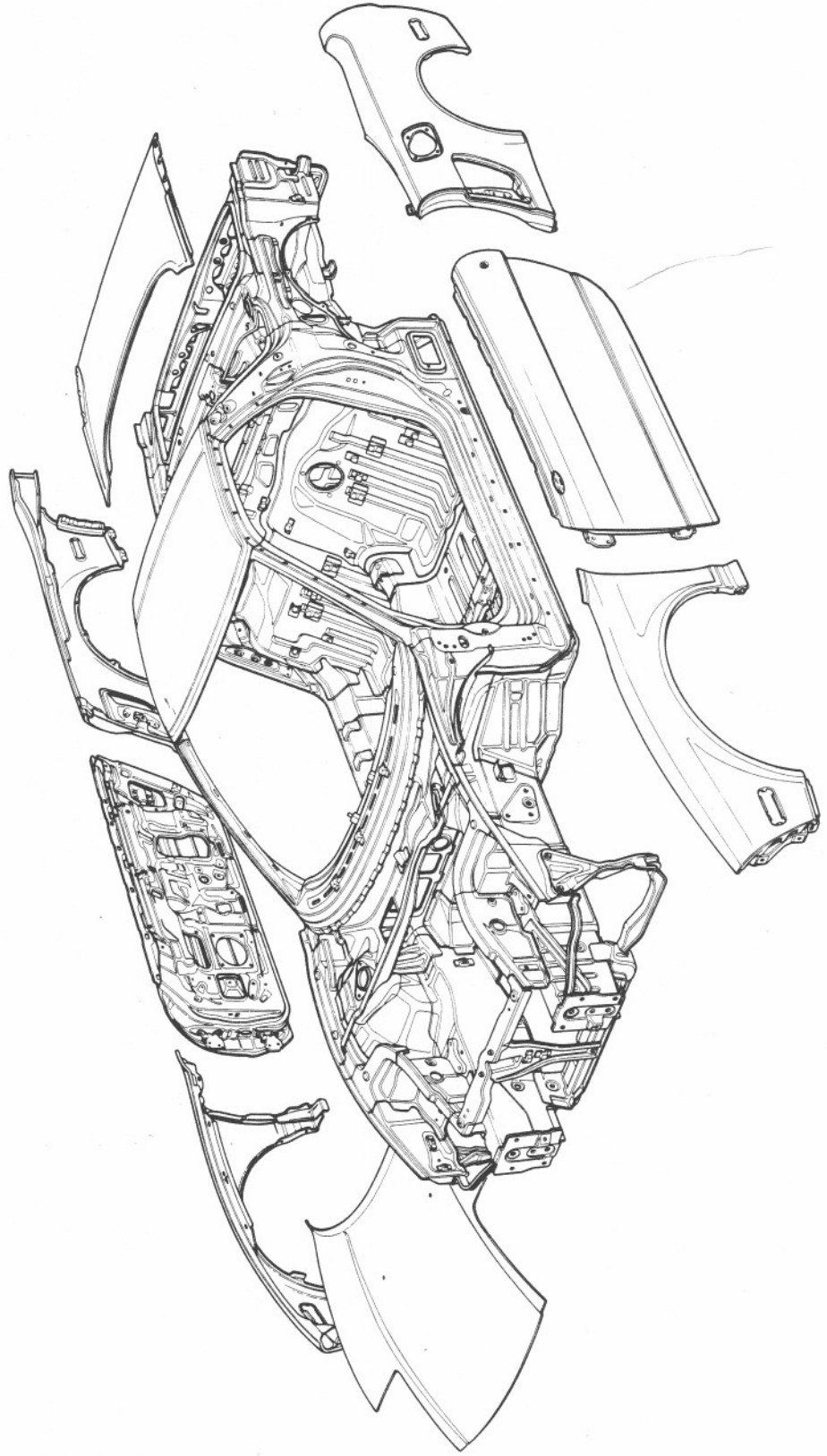
To minimize engine noise intrusion into the passenger cabin, a unique dual pane vertical rear glass panel was developed. The panels are assembled in the frame with a vacuum between the inner and outer panes. This helps to reduce engine noise, acts as a thermal barrier against heat and prevents fogging.

NSX

1991

BODY

UNIT BODY AND EXTERIOR SHEET METAL.....

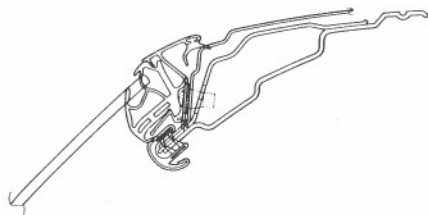


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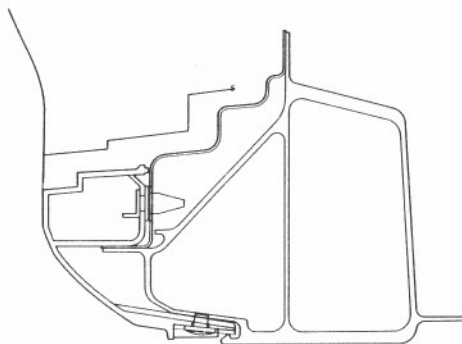
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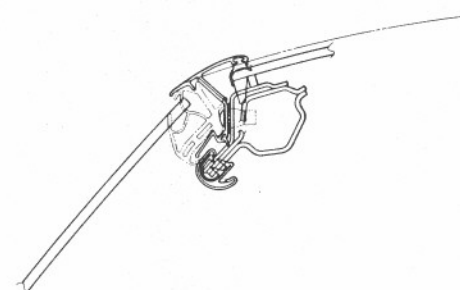
STRUCTURAL DETAILS



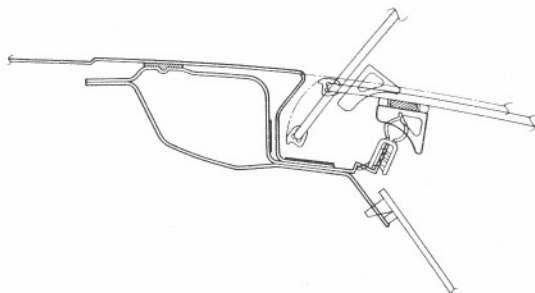
ROOF SIDE RAIL SECTION



SIDE SILL SECTION



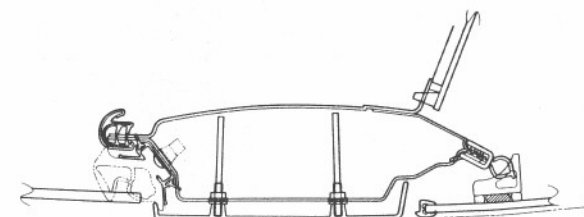
A - PILLAR SECTION



REAR ROOF RAIL SECTION



FRONT ROOF RAIL SECTION



B - PILLAR SECTION

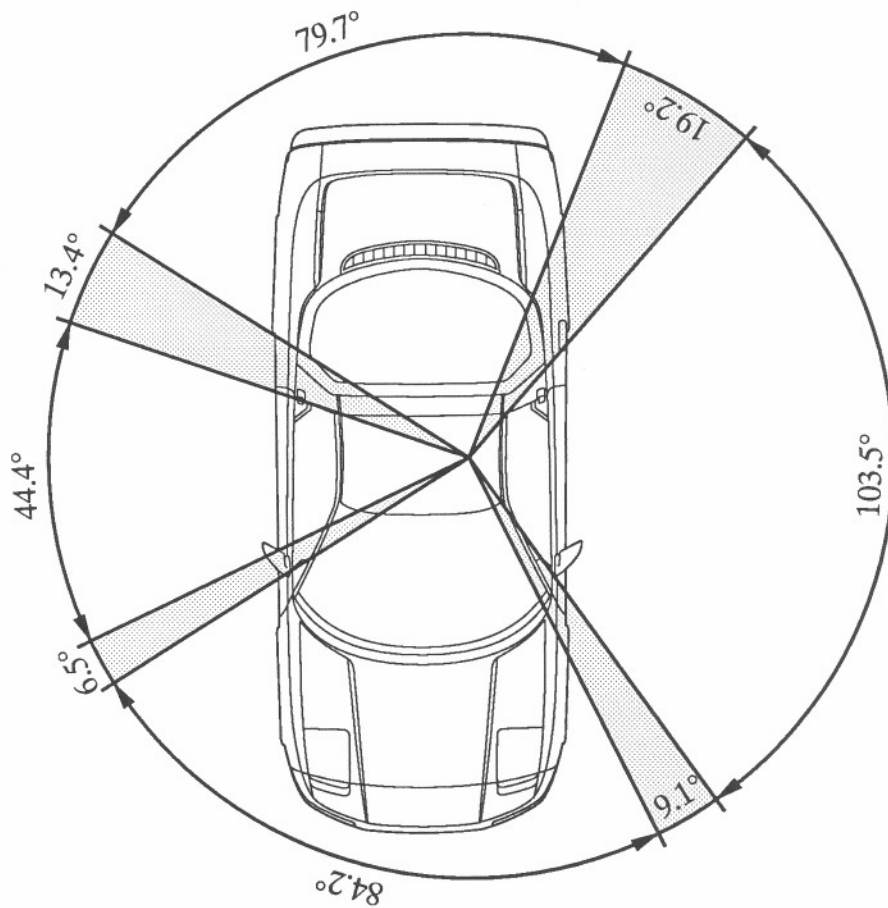
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NSX

BODY

VISIBILITY

ALL-AROUND VISIBILITY: 311.8°

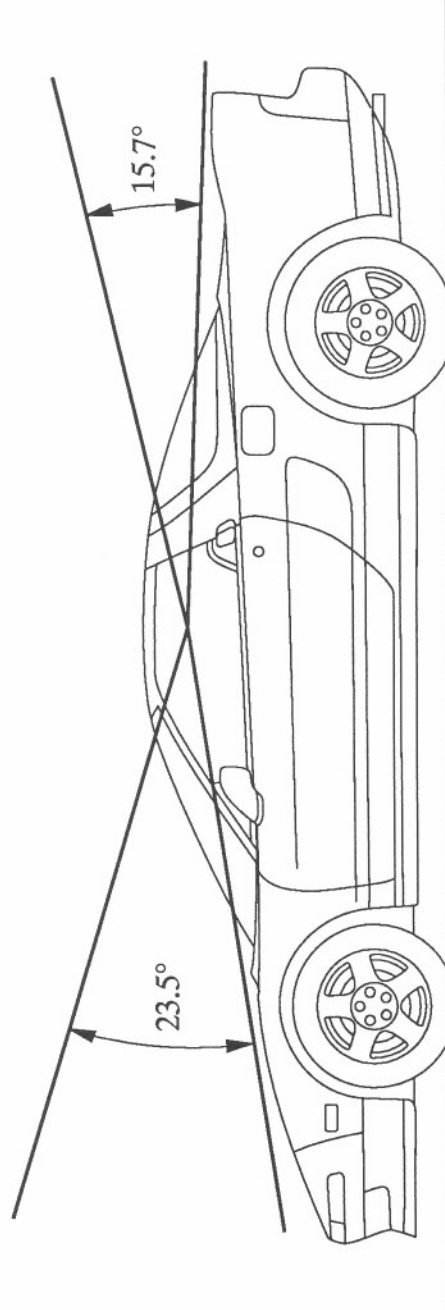


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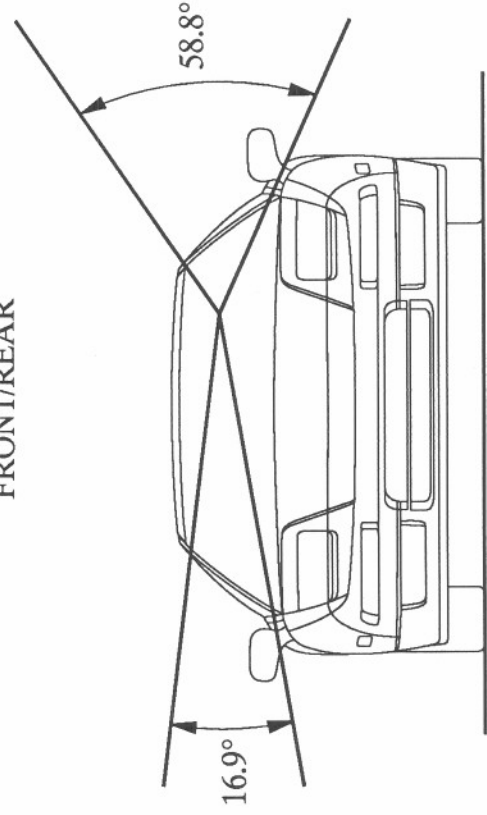
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BODY

VISIBILITY



FRONT/REAR



SIDE

NSX

1991

BODY

EXTERIOR DIMENSIONS

