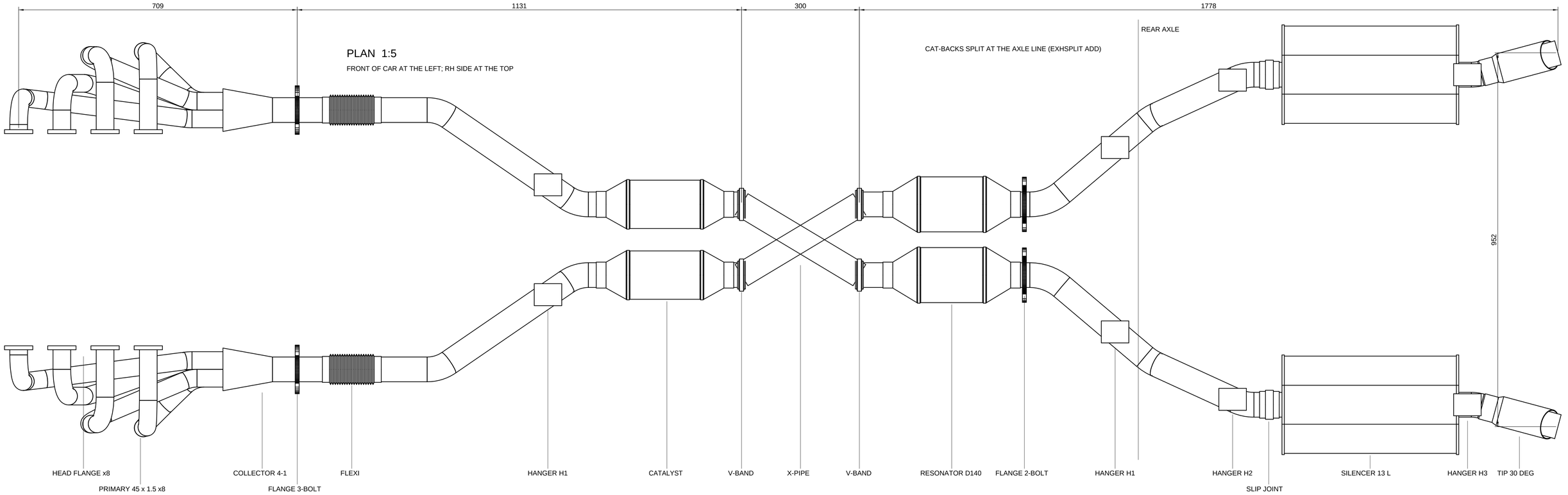
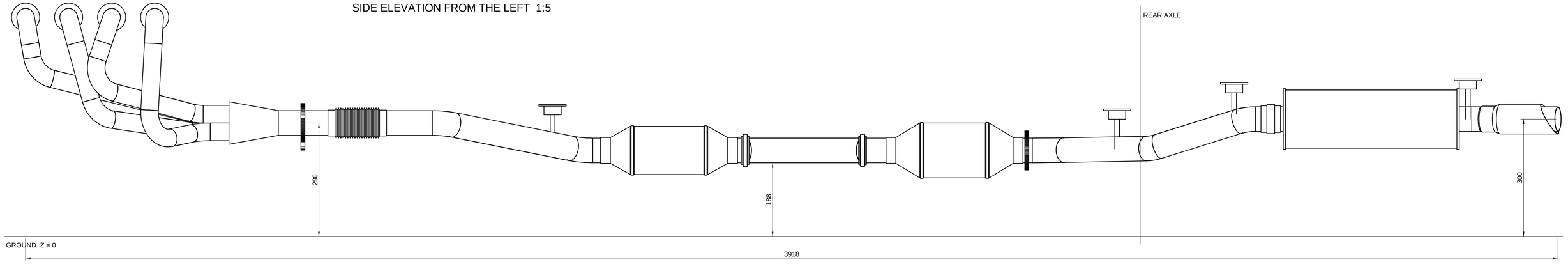
PLAN 1:5

FRONT OF CAR AT THE LEFT; RH SIDE AT THE TOP



HEAD FLANGE CENTRES AT Z = 560

SIDE ELEVATION FROM THE LEFT 1:5



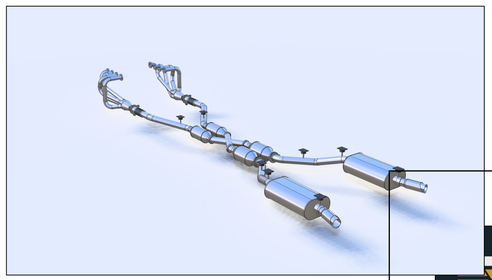
PARTS LIST (EXHPARTS OF ALL RUNS, MERGES, HANGER HARDWARE)

ITEM	PART (LIBRARY ID)	TYPE	FITS TUBE	QTY	FROM
1	flange-2bolt	flange	63 mm	2	EXHPARTS
2	flange-3bolt	flange	63 mm	2	EXHPARTS
3	flexi	flexi	63 mm	2	EXHPARTS
4	catalyst	catalyst	63 mm	2	EXHPARTS
5	vband	vband	63 mm	4	EXHPARTS
6	centre-resonator-140	resonator	63 mm	2	EXHPARTS
7	slip-joint	slip-joint	63 mm	2	EXHPARTS
8	rear-box-13l	silencer	63 mm	2	EXHPARTS
9	tip-angle	tip	63 mm	2	EXHPARTS
10	Head flange, 60 mm port length	head flange	45 mm	8	EXHPORT
11	Collector 4-1, 189 mm body	collector	45 into 63 mm	2	EXHMERGE
12	X-pipe, 180 mm spacing, 300 mm body	x-pipe	63 mm	1	EXHMERGE
13	Hanger: 12 mm rod, rubber, bracket	hanger	at EXHHANGER's places	8	modelled, core 3D

SYSTEM DATA (FROM THE PLUGIN'S REPORTS)

SYSTEM DATA	VALUE	FROM
Engine (designer's input)	4.0 L V8, NA, peak power 7000 rpm	typed into EXHSIZE
Main pipe	63.0 x 1.5 mm (bore 60.0 mm), gas 88 m/s	EXHSIZE
Primary tube	45mm (bore 42.0 mm)	EXHTUNE
Primary, valve to collector	760.8 mm	EXHTUNE, 6500 rpm, EVO 72
Primaries inside +/-10 mm	8 of 8	EXHTUNE
Runs	12 runs, 11811.2 mm centreline	EXHREPORT
Bends, sections	36 bends, 26 sections	EXHREPORT
Tube to cut	8811.1 mm in 26 pieces	EXHREPORT, EXHCUTS
Weight	16.62 kg tube + 31.38 kg parts	EXHREPORT, example masses
Pressure drop, front pipe	5.82 kPa at 600 C	EXHFLOW (estimate)
Pressure drop, cat-back	3.60 kPa at 430 C	EXHFLOW (estimate)
Ground clearance	188.5 mm under the X-pipe	EXHCLEAR
Quote, example rates	2078.23 GBP, before tax	EXHQUOTE

3D VIEW (RENDERSTILL)



NOTES

1. All dimensions in millimetres. Model: x to the rear, y to the car's right, z up from the ground (Z = 0).
2. Tube 304 stainless: mains 63 x 1.5, CLR 94 (one bend on the 126 die); primaries 45 x 1.5, CLR 68.
3. Views are hidden-line projections of the 3D model (FLATSHOT). The side elevation is seen from the left.
4. Primaries tuned with EXHTUNE for 6500 rpm, EVO 72 deg BBDC: 760.8 mm from the valve, 700.8 mm drawn.
5. Hanger places are the plugin's (EXHHANGER); rods, rubbers and brackets are modelled hardware.
6. The chassis used for the clearance check (EXHCLEAR) is a generic shape, not a real car; it is not drawn.
7. Loss coefficients, part masses, dies and rates are example values typed for this demonstration.
8. Sizing and tuning are estimates from engine data: check with the engine builder before fabricating.

Stratal CAD

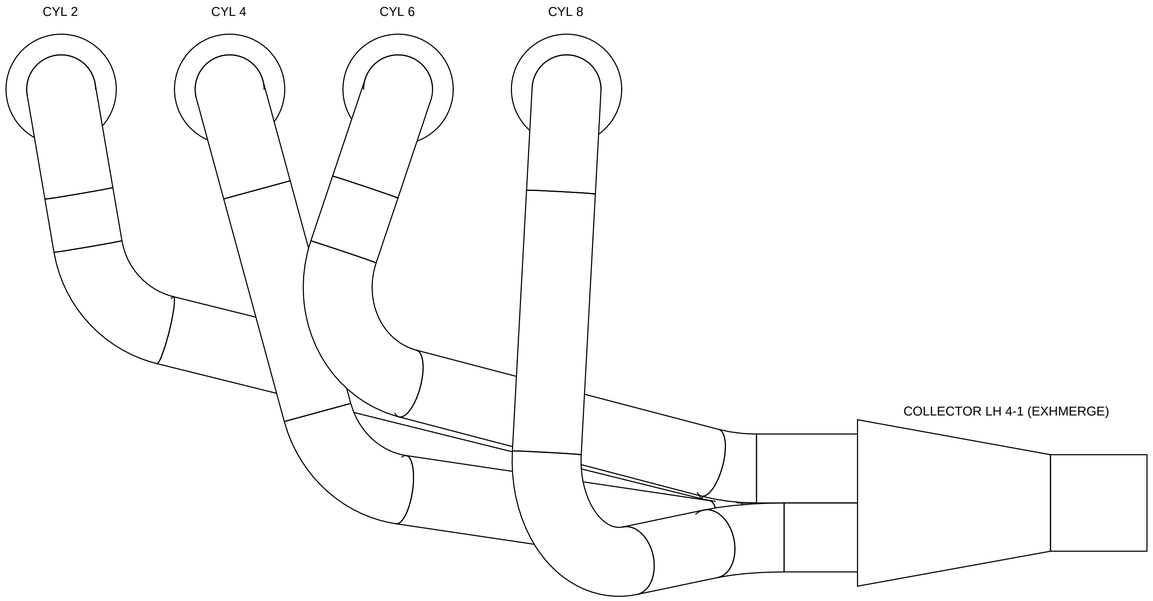
cad.stratal.co.uk

TITLE

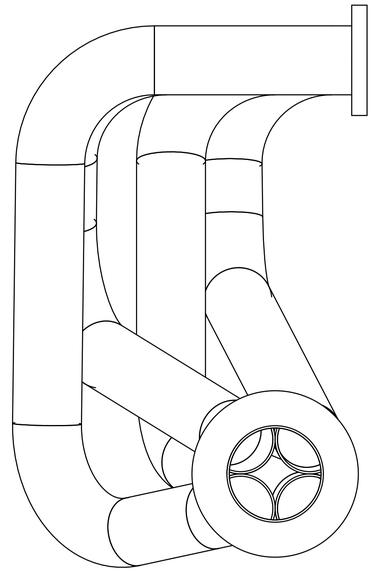
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
GENERAL ARRANGEMENT: PLAN AND SIDE ELEVATION

PROJECT	DRAWN		
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo		
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-001	1 of 7	1:5	A1
SOFTWARE		DATE	
Stratal CAD 0.1.8, Exhaust Designer 1.3.0		12 Nov 2026	
STATUS			
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE			

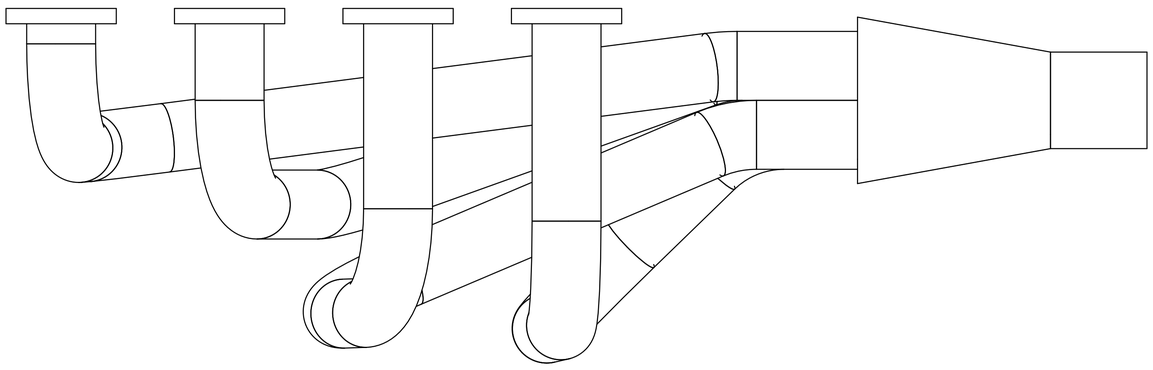
SIDE ELEVATION FROM THE LEFT 1:2



VIEW FROM THE REAR 1:2



PLAN 1:2 (FRONT OF CAR AT THE LEFT)



TUNED LENGTH: THE WORKING (EXHTUNE)

TUNING (EXHTUNE)	VALUE
Displacement	4.00 L (from EXHSIZE)
Target rpm	6500
Cylinders	8 (500 cc each)
EVO (cam data)	72.0° BBDC
ED = 180° + EVO	252.0°
Primary from the valve P = 850 × ED / rpm - 3 (in)	29.95 in = 760.8 mm
Port length (valve to flange)	60.0 mm
Primary to draw (flange to collector)	700.8 mm
Primary ID = 2.1 × sqrt(cc / ((P + 3) × 25)) (in)	1.636 in = 41.6 mm
Suggested primary tube	45mm (bore 42.0 mm)
Tolerance	±10.0 mm

EVERY RUN OF THE SYSTEM, MEASURED (EXHTUNE CSV)

RUN	KIND	MEASURED mm	TARGET mm	DIFF mm	RESULT	START	END
Cat-back RH	other	1895.1				connected	none
Cat-back LH	other	1895.1				connected	none
Front pipe RH	secondary	1207.2		0.0	pass	connected	connected
Front pipe LH	secondary	1207.2		0.0	pass	connected	connected
Primary cyl 1	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 3	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 5	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 7	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 2	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 4	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 6	primary	760.8	760.8	0.0	pass	connected	connected
Primary cyl 8	primary	760.8	760.8	0.0	pass	connected	connected

BEND DATA, LH PRIMARIES (EXHBENDS CSV); CUT LENGTH 700.8 mm EACH

RUN	BEND	MARK mm	ANGLE	SET ANGLE	ROTATION	STRAIGHT AFTER mm
Primary cyl 2	B1	13.1	90.8	93.8	0.0	35.2
Primary cyl 2	B2	156.0	66.5	69.0	82.6	368.7
Primary cyl 2	B3	603.6	15.6	17.0	28.9	78.7
Primary cyl 4	B1	50.0	90.0	93.0	0.0	150.6
Primary cyl 4	B2	307.4	67.8	70.3	68.8	212.5
Primary cyl 4	B3	600.4	21.2	22.7	74.4	75.3
Primary cyl 6	B1	120.7	89.4	92.4	0.0	44.6
Primary cyl 6	B2	271.5	93.8	96.9	67.7	220.6
Primary cyl 6	B3	603.4	26.5	28.1	54.5	66.0
Primary cyl 8	B1	128.8	89.3	92.3	0.0	170.5
Primary cyl 8	B2	405.3	101.3	104.5	45.6	74.2
Primary cyl 8	B3	599.7	44.8	46.8	97.0	48.0

SPRINGBACK FROM TWO TEST BENDS

SPRINGBACK (EXHSPRING)	VALUE
Springback	304 stainless (ss304)
Factor	1.0222
Offset	1.00°
Set angle for 90°	93.0°

BENDER SET-UP SHEET, PRIMARY CYL 2 (EXHCNC SETUP)

SECTION	CUT mm	STEP	DIE CLR	FEED mm	MARK mm	ROTATION	ANGLE	SET ANGLE	STRAIGHT AFTER	CLAMP (40 mm)
S1	700.8	1	68.0	13.1	13.1	0.0	90.8	93.8	35.2	short by 4.8 mm
S1	700.8	2	68.0	35.2	156.0	82.6	66.5	69.0	368.7	ok
S1	700.8	3	68.0	368.7	603.6	28.9	15.6	17.0	78.7	ok

TOOLING GUIDANCE, PRIMARY CYL 2 (EXHTOOLING)

SECTION	BEND	CLR mm	D OF BEND	WALL FACTOR	ANGLE	SET	TOOLING (ESTIMATE)	OUTER WALL	INNER WALL	THINNING %	DIE
S1	B1	68.0	1.51	30.0	90.8	93.8	ball mandrel, 1-2 balls	1.13	2.24	24.9	listed
S1	B2	68.0	1.51	30.0	66.5	69.0	ball mandrel, 1-2 balls	1.13	2.24	24.9	listed
S1	B3	68.0	1.51	30.0	15.6	17.0	ball mandrel, 1-2 balls	1.13	2.24	24.9	listed

CENTRELINE POINTS, PRIMARY CYL 2 (EXHXYZ)

POINT	X mm	Y mm	Z mm	CLR mm
1	-420.000	-280.000	560.000	
2	-420.000	-348.000	560.000	68.000
3	-420.000	-362.000	560.000	68.000
4	-395.000	-360.000	413.448	68.000
5	12.000	-307.500	312.500	68.000
6	32.000	-307.500	312.500	68.000
7	100.000	-307.500	312.500	

CNC PROGRAM, CYL 2 (EXHCNC, LRA)

SECTION	STEP	L mm	R deg	A deg (SET)
S1	1	13.1	0.0	93.8
S1	2	35.2	82.6	69.0
S1	3	368.7	28.9	17.0
S1	4	78.7		

COLLECTOR OUTLET AND MAIN PIPE: THE WORKING (EXHSIZE)

PIPE SIZING (EXHSIZE)	VALUE
Displacement	4.00 L
Peak-power rpm	7000
Aspiration	NA
Volumetric efficiency	0.85
Intake / exhaust temperature	30 / 430 °C
Air-fuel ratio	12.5
Target gas velocity	90 m/s
Intake flow Q_in = Vd × rpm/120 × VE × PR	0.1983 m³/s
Exhaust flow Q_ex = Q_in × Tex/Tin × (1 + 1/AFR)	0.4968 m³/s
Per pipe (dual)	0.2484 m³/s
Bore needed d = sqrt(4 Q / (pi v))	59.3 mm
Recommended tube	63.0 x 1.5 mm (bore 60.0 mm), gas 88 m/s
Next size down	60.0 x 1.5 mm (bore 57.0 mm), gas 97 m/s

NOTES

1. Left bank (cylinders 2, 4, 6, 8); the right bank is its mirror image (cylinders 1, 3, 5, 7).
2. Primaries 45 x 1.5 304 stainless, CLR 68, each 700.8 mm from flange face to collector inlet.
3. The four routes are the designer's; EXHRUN checks each one and EXHTUNE measures it.
4. Tuned length: P = 850 x (180 + EVO) / rpm - 3 inches from the valve, shown with its working.
5. Set angles include the springback fitted from two test bends (EXHSPRING): factor 1.0222, offset 1.0 deg.

Stratal CAD
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TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
LEFT HEADER: VIEWS AND TUNED LENGTHS

PROJECT	DRAWN		
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo		
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-002	2 of 7	1:2	A1
SOFTWARE		DATE	
Stratal CAD 0.1.8, Exhaust Designer 1.3.0		12 Nov 2026	

STATUS
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE

BEND SHEETS (EXHBENDS TABLE): ONE TABLE PER RUN, ONE BLOCK PER SECTION

PRIMARY CYL 1

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	13.1 mm	90.8°	93.8°	0.0°	35.2 mm	700.8
S1	B2	156.0 mm	66.5°	69.0°	-82.6°	368.7 mm	700.8
S1	B3	603.6 mm	15.6°	17.0°	-28.9°	78.7 mm	700.8

PRIMARY CYL 2

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	13.1 mm	90.8°	93.8°	0.0°	35.2 mm	700.8
S1	B2	156.0 mm	66.5°	69.0°	82.6°	368.7 mm	700.8
S1	B3	603.6 mm	15.6°	17.0°	28.9°	78.7 mm	700.8

FRONT PIPE RH

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	-					64.0 mm	64.0
S2	B1	116.9 mm	35.5°	37.3°	0.0°	369.9 mm	623.4
S2	B2	545.0 mm	35.5°	37.3°	180.0°	20.0 mm	623.4
S3	-					19.8 mm	19.8

PRIMARY CYL 3

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	50.0 mm	90.0°	93.0°	0.0°	150.6 mm	700.8
S1	B2	307.4 mm	67.8°	70.3°	-68.8°	212.5 mm	700.8
S1	B3	600.4 mm	21.2°	22.7°	-74.4°	75.3 mm	700.8

PRIMARY CYL 4

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	50.0 mm	90.0°	93.0°	0.0°	150.6 mm	700.8
S1	B2	307.4 mm	67.8°	70.3°	68.8°	212.5 mm	700.8
S1	B3	600.4 mm	21.2°	22.7°	74.4°	75.3 mm	700.8

FRONT PIPE LH

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	-					64.0 mm	64.0
S2	B1	116.9 mm	35.5°	37.3°	0.0°	369.9 mm	623.4
S2	B2	545.0 mm	35.5°	37.3°	180.0°	20.0 mm	623.4
S3	-					19.8 mm	19.8

PRIMARY CYL 5

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	120.7 mm	89.4°	92.4°	0.0°	44.6 mm	700.8
S1	B2	271.5 mm	93.8°	96.9°	-67.7°	220.6 mm	700.8
S1	B3	603.4 mm	26.5°	28.1°	-54.5°	66.0 mm	700.8

PRIMARY CYL 6

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	120.7 mm	89.4°	92.4°	0.0°	44.6 mm	700.8
S1	B2	271.5 mm	93.8°	96.9°	67.7°	220.6 mm	700.8
S1	B3	603.4 mm	26.5°	28.1°	54.5°	66.0 mm	700.8

CAT-BACK RH

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	-					60.0 mm	60.0
S2	-					10.0 mm	10.0
S3	B1	13.8 mm	40.2°	42.1°	0.0°	175.7 mm	278.0
S4	B1	100.9 mm	21.5°	23.0°	0.0°	232.3 mm	455.4
S4	B2	368.5 mm	29.0°	30.7°	73.6°	39.3 mm	455.4
S5	-					32.0 mm	32.0
S6	B1	32.0 mm	15.0°	16.3°	0.0°	3.0 mm	59.6

PRIMARY CYL 7

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	128.8 mm	89.3°	92.3°	0.0°	170.5 mm	700.8
S1	B2	405.3 mm	101.3°	104.5°	-45.6°	74.2 mm	700.8
S1	B3	599.7 mm	44.8°	46.8°	-97.0°	48.0 mm	700.8

PRIMARY CYL 8

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	B1	128.8 mm	89.3°	92.3°	0.0°	170.5 mm	700.8
S1	B2	405.3 mm	101.3°	104.5°	45.6°	74.2 mm	700.8
S1	B3	599.7 mm	44.8°	46.8°	97.0°	48.0 mm	700.8

CAT-BACK LH

Section	Bend	Mark	Angle	Set	Rotate	Then	Cut
S1	-					60.0 mm	60.0
S2	-					10.0 mm	10.0
S3	B1	13.8 mm	40.2°	42.1°	0.0°	175.7 mm	278.0
S4	B1	100.9 mm	21.5°	23.0°	0.0°	232.3 mm	455.4
S4	B2	368.5 mm	29.0°	30.7°	-73.6°	39.3 mm	455.4
S5	-					32.0 mm	32.0
S6	B1	32.0 mm	15.0°	16.3°	0.0°	3.0 mm	59.6

CUT LIST (EXHPARTS, ALL RUNS)

RUN	SECTION	TUBE	WALL	MATERIAL	CUT mm
Primary cyl 1	S1	45mm	1.5	ss304	700.8
Primary cyl 2	S1	45mm	1.5	ss304	700.8
Primary cyl 3	S1	45mm	1.5	ss304	700.8
Primary cyl 4	S1	45mm	1.5	ss304	700.8
Primary cyl 5	S1	45mm	1.5	ss304	700.8
Primary cyl 6	S1	45mm	1.5	ss304	700.8
Primary cyl 7	S1	45mm	1.5	ss304	700.8
Primary cyl 8	S1	45mm	1.5	ss304	700.8
Front pipe RH	S1	63mm	1.5	ss304	64.0
Front pipe RH	S2	63mm	1.5	ss304	623.4
Front pipe RH	S3	63mm	1.5	ss304	19.8
Front pipe LH	S1	63mm	1.5	ss304	64.0
Front pipe LH	S2	63mm	1.5	ss304	623.4
Front pipe LH	S3	63mm	1.5	ss304	19.8
Cat-back RH	S1	63mm	1.5	ss304	60.0
Cat-back RH	S2	63mm	1.5	ss304	10.0
Cat-back RH	S3	63mm	1.5	ss304	278.0
Cat-back RH	S4	63mm	1.5	ss304	455.4
Cat-back RH	S5	63mm	1.5	ss304	32.0
Cat-back RH	S6	63mm	1.5	ss304	59.6
Cat-back LH	S1	63mm	1.5	ss304	60.0
Cat-back LH	S2	63mm	1.5	ss304	10.0
Cat-back LH	S3	63mm	1.5	ss304	278.0
Cat-back LH	S4	63mm	1.5	ss304	455.4
Cat-back LH	S5	63mm	1.5	ss304	32.0
Cat-back LH	S6	63mm	1.5	ss304	59.6

CUTTING PLAN AND LABELS (EXHCUTS)

CUT	MARK (LABEL)	TUBE	CUT mm	BENDS	BAR
1	Front pipe RH-S2	63mm x 1.5 ss304	623.4	2	1
2	Front pipe LH-S2	63mm x 1.5 ss304	623.4	2	1
3	Cat-back RH-S4	63mm x 1.5 ss304	455.4	2	1
4	Cat-back LH-S4	63mm x 1.5 ss304	455.4	2	1
5	Cat-back RH-S3	63mm x 1.5 ss304	278.0	1	1
6	Cat-back LH-S3	63mm x 1.5 ss304	278.0	1	1
7	Front pipe RH-S1	63mm x 1.5 ss304	64.0	0	1
8	Front pipe LH-S1	63mm x 1.5 ss304	64.0	0	1
9	Cat-back RH-S1	63mm x 1.5 ss304	60.0	0	1
10	Cat-back LH-S1	63mm x 1.5 ss304	60.0	0	1
11	Cat-back RH-S6	63mm x 1.5 ss304	59.6	1	1
12	Cat-back LH-S6	63mm x 1.5 ss304	59.6	1	1
13	Cat-back RH-S5	63mm x 1.5 ss304	32.0	0	1
14	Cat-back LH-S5	63mm x 1.5 ss304	32.0	0	1
15	Front pipe RH-S3	63mm x 1.5 ss304	19.8	0	1
16	Front pipe LH-S3	63mm x 1.5 ss304	19.8	0	1
17	Cat-back RH-S2	63mm x 1.5 ss304	10.0	0	1
18	Cat-back LH-S2	63mm x 1.5 ss304	10.0	0	1
19	Primary cyl 5-S1	45mm x 1.5 ss304	700.8	3	1
20	Primary cyl 6-S1	45mm x 1.5 ss304	700.8	3	1
21	Primary cyl 7-S1	45mm x 1.5 ss304	700.8	3	1
22	Primary cyl 8-S1	45mm x 1.5 ss304	700.8	3	1
23	Primary cyl 1-S1	45mm x 1.5 ss304	700.8	3	1
24	Primary cyl 2-S1	45mm x 1.5 ss304	700.8	3	1
25	Primary cyl 3-S1	45mm x 1.5 ss304	700.8	3	1
26	Primary cyl 4-S1	45mm x 1.5 ss304	700.8	3	1
	Offcut of bar 1	63mm x 1.5 ss304	2759.5		1
	Used, kerf included, of bar 1	63mm x 1.5 ss304	3204.5		1
	Offcut of bar 1	45mm x 1.5 ss304	377.4		1
	Used, kerf included, of bar 1	45mm x 1.5 ss304	5606.6		1

WELD AND ASSEMBLY SEQUENCE, CAT-BACK LH (EXHWELD)

STEP	AT mm	JOINT	FROM	TO	WHAT TO DO
1	0.0	weld	x #50 port out2	S1	tack and check the alignment then weld to the port
2	60.0	weld	S1	centre-resonator-140	weld to the component's spigot
3	410.0	weld	centre-resonator-140	S2	weld to the component's spigot
4	420.0	flange	S2	S3	weld a flange to each piece then bolt them together
5	698.0	weld	S3	S4	butt weld (split)
6	1153.4	slip-joint	S4	S5	slip one piece over the other then clamp
7	1185.4	weld	S5	rear-box-13l	weld to the component's spigot
8	1635.4	weld	rear-box-13l	S6	weld to the component's spigot
9	1695.0	weld	S6	tip-angle	weld to the component's spigot

WELD AND ASSEMBLY SEQUENCE, FRONT PIPE LH (EXHWELD)

STEP	AT mm	JOINT	FROM	TO	WHAT TO DO
1	0.0	weld	collector #1575 port out	S1	tack and check the alignment then weld to the port
2	64.0	weld	S1	flexi	weld to the component's spigot
3	214.0	weld	flexi	S2	weld to the component's spigot
4	837.4	weld	S2	catalyst	weld to the component's spigot
5	1187.4	weld	catalyst	S3	weld to the component's spigot
6	1207.2	weld	S3	x #50 port in1	tack and check the alignment then weld to the port

WELD AND ASSEMBLY SEQUENCE, PRIMARY CYL 2 (EXHWELD)

STEP	AT mm	JOINT	FROM	TO	WHAT TO DO
1	0.0	weld	head flange #1465 port out	S1	tack and check the alignment then weld to the port
2	700.8	weld	S1	collector #1575 port in4	tack and check the alignment then weld to the port

CNC BENDER PROGRAMS (EXHCNC, LRA)

RUN	SECTION	STEP	L mm	R deg	A deg (SET)
Front pipe LH	S1	1	64.0		
Front pipe LH	S2	1	116.9	0.0	37.3
Front pipe LH	S2	2	369.9	180.0	37.3
Front pipe LH	S2	3	20.0		
Front pipe LH	S3	1	19.8		
Cat-back LH	S1	1	60.0		
Cat-back LH	S2	1	10.0		
Cat-back LH	S3	1	13.8	0.0	42.1
Cat-back LH	S3	2	175.7		
Cat-back LH	S4	1	100.9	0.0	23.0
Cat-back LH	S4	2	232.3	-73.6	30.7
Cat-back LH	S4	3	39.3		
Cat-back LH	S5	1	32.0		
Cat-back LH	S6	1	32.0	0.0	16.3
Cat-back LH	S6	2	3.0		

SHOP LIBRARY FILE (EXHLIB LOAD)

SHOP LIBRARY (EXAMPLE VALUES)	VALUE
Tube 45mm: bender dies (CLR)	68 and 90 mm
Tube 63mm: bender dies (CLR)	94 and 126 mm
304 stainless: clamp length	40 mm
304 stainless: springback factor	1.0222 (EXHSPRING)
304 stainless: springback offset	1.00 deg (EXHSPRING)
Stock length	6000 mm

BENDER SET-UP SHEETS, 63 mm RUNS (EXHCNC SETUP)

RUN	SECTION	CUT mm	STEP	DIE CLR	FEED mm	MARK mm	ROTATION	ANGLE	SET ANGLE	STRAIGHT AFTER	CLAMP (40 mm)
Front pipe RH	S1	64.0	0		64.0						
Front pipe RH	S2	623.4	1	94.0	116.9	116.9	0.0	35.5	37.3	369.9	ok
Front pipe RH	S2	623.4	2	94.0	369.9	545.0	180.0	35.5	37.3	20.0	short by 20.0 mm
Front pipe RH	S3	19.8	0		19.8						
Front pipe LH	S1	64.0	0		64.0						
Front pipe LH	S2	623.4	1	94.0	116.9	116.9	0.0	35.5	37.3	369.9	ok
Front pipe LH	S2	623.4	2	94.0	369.9	545.0	180.0	35.5	37.3	20.0	short by 20.0 mm
Front pipe LH	S3	19.8	0		19.8						
Cat-back RH	S1	60.0	0		60.0						
Cat-back RH	S2	10.0	0		10.0						
Cat-back RH	S3	278.0	1	126.0	13.8	13.8	0.0	40.2	42.1	175.7	ok
Cat-back RH	S4	455.4	1	94.0	100.9	100.9	0.0	21.5	23.0	232.3	ok
Cat-back RH	S4	455.4	2	94.0	232.3	368.5	73.6	29.0	30.7	39.3	short by 0.7 mm
Cat-back RH	S5	32.0	0		32.0						
Cat-back RH	S6	59.6	1	94.0	32.0	32.0	0.0	15.0	16.3	3.0	short by 37.0 mm
Cat-back LH	S1	60.0	0		60.0						
Cat-back LH	S2	10.0	0		10.0						
Cat-back LH	S3	278.0	1	126.0	13.8	13.8	0.0	40.2	42.1	175.7	ok
Cat-back LH	S4	455.4	1	94.0	100.9	100.9	0.0	21.5	23.0	232.3	ok
Cat-back LH	S4	455.4	2	94.0	232.3	368.5	-73.6	29.0	30.7	39.3	short by 0.7 mm
Cat-back LH	S5	32.0	0		32.0						
Cat-back LH	S6	59.6	1	94.0	32.0	32.0	0.0	15.0	16.3	3.0	short by 37.0 mm

TOOLING GUIDANCE, 63 mm RUNS (EXHTOOLING)

RUN	SECTION	BEND	CLR mm	D OF BEND	WALL FACTOR	ANGLE	SET	TOOLING (ESTIMATE)	OUTER WALL	INNER WALL	THINNING %	DIE
Front pipe RH	S2	B1	94.0	1.49	42.0	35.5	37.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Front pipe RH	S2	B2	94.0	1.49	42.0	35.5	37.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Front pipe LH	S2	B1	94.0	1.49	42.0	35.5	37.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Front pipe LH	S2	B2	94.0	1.49	42.0	35.5	37.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back RH	S3	B1	126.0	2.00	42.0	40.2	42.1	ball mandrel, 1-2 balls	1.20	2.00	20.0	listed
Cat-back RH	S4	B1	94.0	1.49	42.0	21.5	23.0	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back RH	S4	B2	94.0	1.49	42.0	29.0	30.7	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back RH	S6	B1	94.0	1.49	42.0	15.0	16.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back LH	S3	B1	126.0	2.00	42.0	40.2	42.1	ball mandrel, 1-2 balls	1.20	2.00	20.0	listed
Cat-back LH	S4	B1	94.0	1.49	42.0	21.5	23.0	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back LH	S4	B2	94.0	1.49	42.0	29.0	30.7	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed
Cat-back LH	S6	B1	94.0	1.49	42.0	15.0	16.3	ball mandrel, 1-2 balls	1.12	2.26	25.1	listed

NOTES

1. Bend tables are drawn by EXHBENDS Table and follow their runs; text size set with its Text option.
2. Marks are measured from the start end of each section to the start of the bend.
3. Set angles include the springback fit (EXHSPRING): set = angle x 1.0222 + 1.0 deg.
4. Cutting plan: 6 m stock, 2 mm kerf, longest first (EXHCUTS); an estimate, check before cutting.
5. A joint placed on a run's end at a port is listed as a weld to the port (see FINDINGS).

Stratal CAD

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TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
BEND SHEETS, CUT LIST, CUTTING PLAN AND WELD SEQUENCE

PROJECT	DRAWN
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo

DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-003	3 of 7	As noted	A1

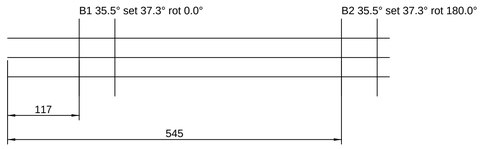
SOFTWARE	DATE
Stratal CAD 0.1.8, Exhaust Designer 1.3.0	12 Nov 2026

STATUS
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE

FRONT PIPE RH (EXHFLAT)

S1 — 63mm x 1.5 304 stainless — cut 64.0 mm

S2 — 63mm x 1.5 304 stainless — cut 623.4 mm

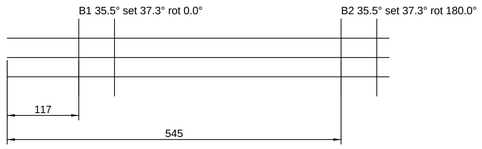


S3 — 63mm x 1.5 304 stainless — cut 19.8 mm

FRONT PIPE LH (EXHFLAT)

S1 — 63mm x 1.5 304 stainless — cut 64.0 mm

S2 — 63mm x 1.5 304 stainless — cut 623.4 mm



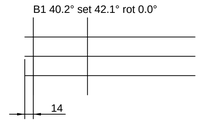
S3 — 63mm x 1.5 304 stainless — cut 19.8 mm

CAT-BACK RH (EXHFLAT)

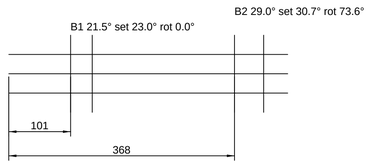
S1 — 63mm x 1.5 304 stainless — cut 60.0 mm

S2 — 63mm x 1.5 304 stainless — cut 10.0 mm

S3 — 63mm x 1.5 304 stainless — cut 278.0 mm

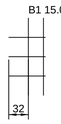


S4 — 63mm x 1.5 304 stainless — cut 455.4 mm



S5 — 63mm x 1.5 304 stainless — cut 32.0 mm

S6 — 63mm x 1.5 304 stainless — cut 59.6 mm

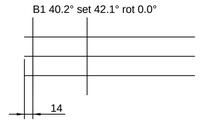


CAT-BACK LH (EXHFLAT)

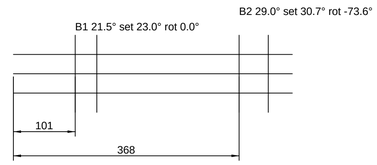
S1 — 63mm x 1.5 304 stainless — cut 60.0 mm

S2 — 63mm x 1.5 304 stainless — cut 10.0 mm

S3 — 63mm x 1.5 304 stainless — cut 278.0 mm

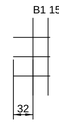


S4 — 63mm x 1.5 304 stainless — cut 455.4 mm



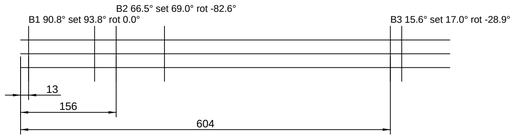
S5 — 63mm x 1.5 304 stainless — cut 32.0 mm

S6 — 63mm x 1.5 304 stainless — cut 59.6 mm



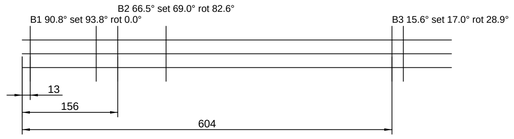
PRIMARY CYL 1 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



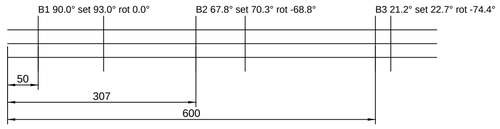
PRIMARY CYL 2 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



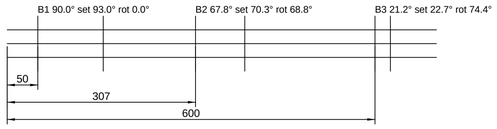
PRIMARY CYL 3 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



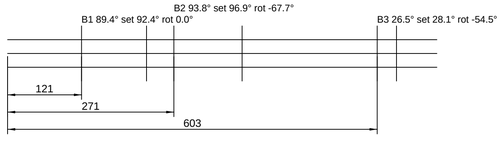
PRIMARY CYL 4 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



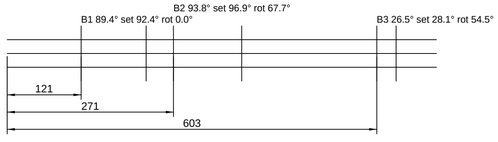
PRIMARY CYL 5 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



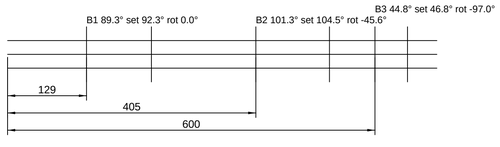
PRIMARY CYL 6 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



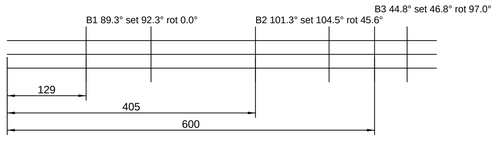
PRIMARY CYL 7 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



PRIMARY CYL 8 (EXHFLAT)

S1 — 45mm x 1.5 304 stainless — cut 700.8 mm



NOTES

1. Each section is drawn unrolled, true to length at 1:5: bend starts and ends marked from the start end.
2. Labels give each bend's angle, set angle (springback included) and rotation from the bend before.
3. Drawn by EXHFLAT for all twelve runs; the drawings follow their runs when they change.

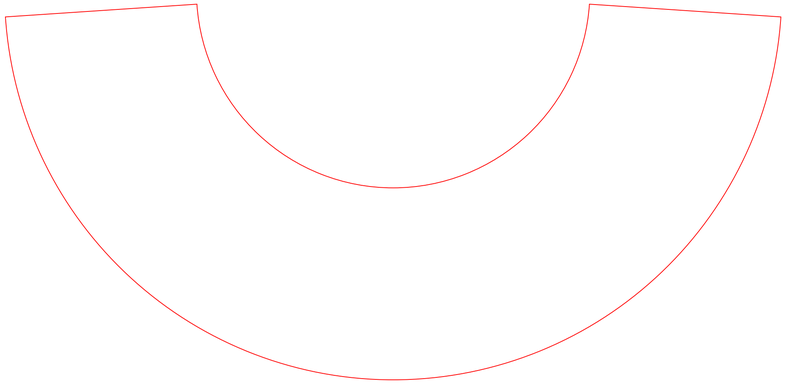
Stratal CAD

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TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
FLAT WORKSHOP DRAWINGS OF EVERY SECTION

PROJECT	DRAWN		
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo		
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-004	4 of 7	1:5	A1
SOFTWARE		DATE	
Stratal CAD 0.1.8, Exhaust Designer 1.3.0		12 Nov 2026	
STATUS			
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE			

TRUE SIZE 1:1. OUTLINES ON LAYER EXH-CUT, LABELS ON EXH-FAB; CURVES AS STRAIGHT PIECES; ORDINATES FOR MARKING OUT IN THE CSV FILES.

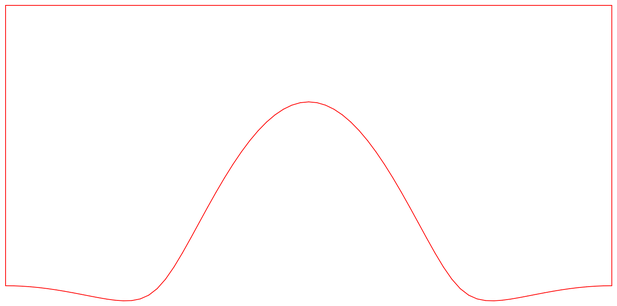


Cone 123.0 mm to 63.0 mm OD x 55.0 mm, t 1.5 mm: R 126.9 mm / 64.2 mm, 172.4°

CONE: CATALYST INLET (EXHCONE)

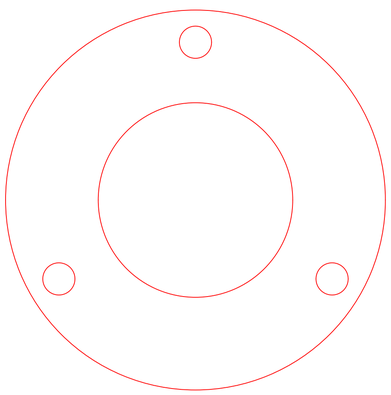
CONE: CATALYST INLET (EXHCONE)	VALUE
EXHCONE	flat pattern
Shape	cone (concentric), developed on the mean diameters
Outer radius	126.9 mm
Inner radius	64.2 mm
Included angle	172.4°
Slant length	62.6 mm
Seam chord at the outer radius	253.2 mm
Blank width (approx.)	253.2 mm

Notch 63.0 mm on 63.0 mm at 45.0°: wrap on the branch, top line square, cut the curve



NOTCH: DRONE BRANCH AT 45 DEG (EXHNOTCH)

NOTCH: DRONE BRANCH AT 45 DEG (EXHNOTCH)	VALUE
EXHNOTCH	flat pattern
Branch / header	63.0 mm x 1.5 mm on 63.0 mm
Angle between axes	45.0°
Offset of axes	0.0 mm
Template girth (branch OD)	197.9 mm
Depth of cut	64.9 mm
Fit	branch bore on the header's outside; 0 and 180 degrees lie in the plane of both axes

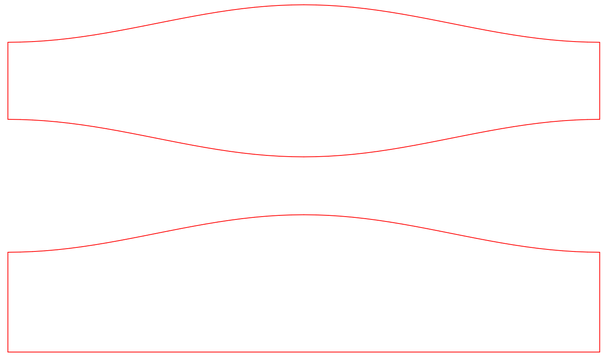


FLANGE PLATE, 3-BOLT (EXHPLATE)

FLANGE PLATE, 3-BOLT (EXHPLATE)	VALUE
EXHPLATE	flat pattern
Shape	round 124.0 mm, 3 bolts on 103.0 mm PCD
Bore (tube OD + fit)	63.5 mm
Bolt holes	3 x 10.5 mm
Outside diameter	124.0 mm

Flange plate round 124.0 mm, 3 bolts on 103.0 mm PCD, bore 63.5 mm, holes 10.5 mm, t 10.0 mm

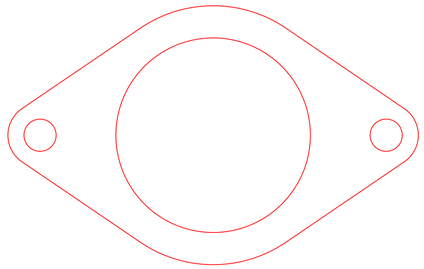
Full gore x 3: 49.6 mm outside, 25.2 mm inside (seam at the inside of the bend)



End piece x 2: 44.8 mm outside, 32.6 mm inside, square end at the bottom

LOBSTER-BACK BEND, 5 PIECES (EXHLOBSTER)

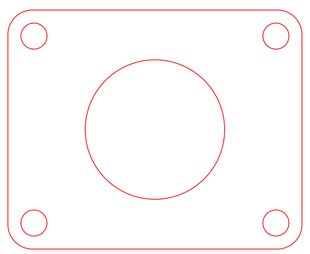
LOBSTER-BACK BEND, 5 PIECES (EXHLOBSTER)	VALUE
EXHLOBSTER	flat pattern
Pieces	5 (3 full gores, 2 end pieces), 4 welds
Mitre per face	11.2°
Girth (mean diameter)	193.2 mm
Full gore outside / inside	49.6 mm / 25.2 mm
End piece outside / inside	44.8 mm / 32.6 mm
Centreline through the pieces	149.6 mm (true arc 147.7 mm)



Flange plate oval 2-bolt, bolts 113.0 mm apart, bore 63.5 mm, holes 10.5 mm, t 10.0 mm

FLANGE PLATE, 2-BOLT (EXHPLATE)

FLANGE PLATE, 2-BOLT (EXHPLATE)	VALUE
EXHPLATE	flat pattern
Shape	oval 2-bolt, bolts 113.0 mm apart
Bore (tube OD + fit)	63.5 mm
Bolt holes	2 x 10.5 mm
Middle width	84.5 mm
Overall length	134.0 mm



HEAD FLANGE PLATE (EXHPLATE)

HEAD FLANGE PLATE (EXHPLATE)	VALUE
EXHPLATE	flat pattern
Shape	rectangular 96.0 mm x 78.0 mm, 4 bolts
Bore (tube OD + fit)	45.5 mm
Bolt holes	4 x 8.5 mm
Plate	96.0 mm x 78.0 mm, corner 8.0 mm

Flange plate rectangular 96.0 mm x 78.0 mm, 4 bolts, bore 45.5 mm, holes 8.5 mm, t 10.0 mm

Stratal CAD

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TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
FLAT PATTERNS: CONE, LOBSTER BEND, NOTCH, PLATES

PROJECT	DRAWN
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo

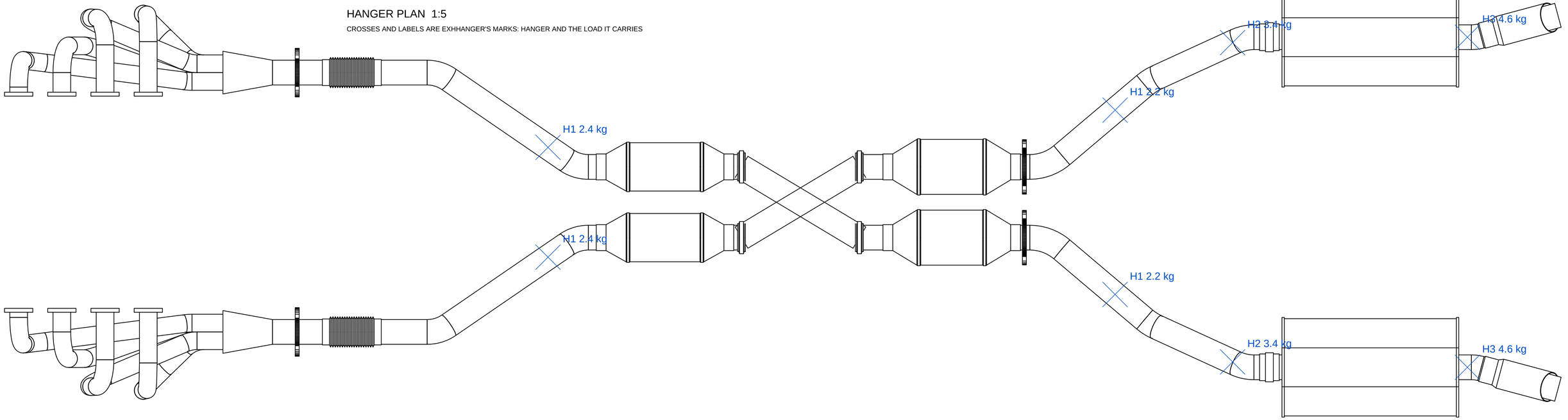
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-005	5 of 7	As noted	A1

SOFTWARE	DATE
Stratal CAD 0.1.8, Exhaust Designer 1.3.0	12 Nov 2026

STATUS
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE

HANGER PLAN 1:5

CROSSES AND LABELS ARE EXHHANGER'S MARKS: HANGER AND THE LOAD IT CARRIES



HANGER SCHEDULE (EXHHANGER CSV)

RUN	SUPPORT	ALONG mm	X mm	Y mm	Z mm	LOAD kg	MOVES HOT mm
Front pipe RH	start	0.0	289.0	330.0	290.0	1.424	0.0
Front pipe RH	H1	700.0	927.4	139.8	234.5	2.434	7.3
Front pipe RH	end	1207.2	1420.0	90.0	220.0	2.502	12.6
Front pipe LH	start	0.0	289.0	-330.0	290.0	1.424	0.0
Front pipe LH	H1	700.0	927.4	-139.8	234.5	2.434	7.3
Front pipe LH	end	1207.2	1420.0	-90.0	220.0	2.502	12.6
Cat-back RH	start	0.0	1720.0	90.0	220.0	2.792	0.0
Cat-back RH	H1	700.0	2370.8	234.6	223.3	2.203	4.1
Cat-back RH	H2	1056.5	2670.0	406.2	290.6	3.439	6.2
Cat-back RH	H3	1657.4	3267.6	420.0	300.0	4.611	9.8
Cat-back LH	start	0.0	1720.0	-90.0	220.0	2.792	0.0
Cat-back LH	H1	700.0	2370.8	-234.6	223.3	2.203	4.1
Cat-back LH	H2	1056.5	2670.0	-406.2	290.6	3.439	6.2
Cat-back LH	H3	1657.4	3267.6	-420.0	300.0	4.611	9.8

GAS FLOW AND PRESSURE DROP, CAT-BACK LH (EXHFLOW)

ITEM (CAT-BACK LH)	FROM mm	TO mm	TUBE mm	K	DROP Pa
S1 straight	0.0	433.8	83.8	0.0302	58.5
centre-resonator-140	60.0	410.0	0.0	0.3500	678.3
B1 bend 40.2°	433.8	522.3	88.5	0.1213	235.1
S2 straight	522.3	798.9	276.6	0.0997	193.2
B2 bend 21.5°	798.9	834.2	35.3	0.0605	117.3
S3 straight	834.2	1066.5	232.3	0.0837	162.2
B3 bend 29.0°	1066.5	1114.1	47.6	0.0816	158.2
S4 straight	1114.1	1667.4	103.3	0.0372	72.1
rear-box-13l	1185.4	1635.4	0.0	0.9000	1744.1
B4 bend 15.0°	1667.4	1692.0	24.6	0.0422	81.8
S5 straight	1692.0	1895.1	3.0	0.0011	2.1
tip-angle	1695.0	1895.0	0.0	0.0500	96.9
total			895.1		3599.8
velocity_m_s					87.86
reynolds					79214

GAS FLOW, FRONT PIPE LH (EXHFLOW)

ITEM (FRONT PIPE LH)	FROM mm	TO mm	TUBE mm	K	DROP Pa
S1 straight	0.0	330.9	180.9	0.0663	159.5
flexi	64.0	214.0	0.0	0.2000	481.3
B1 bend 35.5°	330.9	389.2	58.3	0.1003	241.5
S2 straight	389.2	759.0	369.9	0.1355	326.2
B2 bend 35.5°	759.0	817.4	58.3	0.1003	241.5
S3 straight	817.4	1207.2	39.9	0.0146	35.2
catalyst	837.4	1187.4	0.0	1.8000	4331.6
total			707.2		5816.6
velocity_m_s					109.10
reynolds					69207

QUOTE FROM THE EXAMPLE RATES FILE (EXHQUOTE)

GROUP	ITEM	QTY	UNIT	RATE GBP	TOTAL GBP	NOTE
Tube	63mm x 1.5 ss304	1	bar	96.00	96.00	3.24 m used
Tube	45mm x 1.5 ss304	5.62	m	11.50	64.66	1 stock length(s) to buy
Parts	vband	4	each	14.50	58.00	
Parts	centre-resonator-140	2	each	78.00	156.00	
Parts	flange-2bolt	2	each	6.50	13.00	
Parts	slip-joint	2	each	9.00	18.00	
Parts	rear-box-13l	2	each	142.00	284.00	
Parts	tip-angle	2	each	36.00	72.00	
Parts	flange-3bolt	2	each	8.50	17.00	
Parts	flexi	2	each	24.00	48.00	
Parts	catalyst	2	each	185.00	370.00	
Labour	setup	0.75	h	48.00	36.00	1 x 45.0 min
Labour	cuts	1.30	h	48.00	62.40	26 x 3.0 min
Labour	bends	2.40	h	48.00	115.20	36 x 4.0 min
Labour	welds	6.30	h	48.00	302.40	42 x 9.0 min
Labour	joints (flange, V-band, slip)	0.40	h	48.00	19.20	4 x 6.0 min
Summary	materials		GBP		1196.66	
Summary	labour	11.15	h		535.20	
Summary	markup		GBP		346.37	
Summary	total		GBP		2078.23	before tax

SYSTEM REPORT (EXHREPORT CSV)

RUN	TUBE	OD	WALL	MATERIAL	CENTRELINE mm	POINTS	BENDS	SECTIONS	CUT mm	TUBE kg	PARTS	PARTS kg	NO MASS	STATE
Cat-back RH	63mm	63.0	1.5	ss304	1895.1	8	4	6	895.0	2.075	6	10.970	0	ok
Cat-back LH	63mm	63.0	1.5	ss304	1895.1	8	4	6	895.0	2.075	6	10.970	0	ok
Front pipe RH	63mm	63.0	1.5	ss304	1207.2	6	2	3	707.2	1.640	4	4.720	0	ok
Front pipe LH	63mm	63.0	1.5	ss304	1207.2	6	2	3	707.2	1.640	4	4.720	0	ok
Primary cyl 1	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 3	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 5	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 7	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 2	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 4	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 6	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Primary cyl 8	45mm	45.0	1.5	ss304	700.8	7	3	1	700.8	1.149	0	0.000	0	ok
Total (12 runs)					11811.2	84	36	26	8811.1	16.624	20	31.380	0	

CLEARANCE: NEAREST AND SHIELD GAPS (EXHCLEAR)

OBSTACLE (CAT-BACK LH)	GAP mm	AT mm	RESULT
Cat-back RH	117.0	0.0	ok
Front pipe RH	286.9	0.0	ok
Front pipe LH	237.0	0.0	ok
Solid #7 (CTX-ENGINE)	39.6	588.5	shield
Solid #10 (CTX-CHASSIS)	47.6	1082.2	shield
Solid #11 (CTX-CHASSIS)	58.5	1815.3	shield
Solid #15 (CTX-DRIVELINE)	73.2	832.8	shield
Ground (Z 0.0 mm)	188.5	0.0	ok

WEIGHT AND HEAT GROWTH (EXHHANGER PANEL)

HANGERS AND HEAT GROWTH	FRONT PIPE RH	CAT-BACK RH
Held	both ends (held ends are supports too)	the start (held ends are supports too)
Weight	6.36 kg (tube 2.318 kg/m)	13.05 kg (tube 2.318 kg/m)
Heat growth	18.70 um/(m K) x 580 K: the run grows 13.1 mm; its end moves 12.6 mm from the fixed point at 0.0 mm	18.70 um/(m K) x 330 K: the run grows 11.7 mm; its end moves 11.2 mm from the fixed point at 0.0 mm

EXPANSION: 18.70 UM/(M K) (CLEVELAND-CLIFFS, 304/304L PRODUCT DATA, 05/2021, FOR 0 TO 649 C); TYPICAL, FROM THE MAKER'S DATA SHEET, CHECK FOR YOUR MATERIAL

NOTES

1. Hanger places, loads and heat growth are EXHHANGER's: span up to 700, free end up to 350 (designer's settings).
2. Front pipes held at both ends (collector flange, X-pipe V-band); cat-backs held at the X-pipe V-band.
3. Heat growth: free expansion of 304 stainless from the fixed start; rise 580 K front pipes, 330 K cat-backs.
4. Gas flow (EXHFLOW): EXHSIZE's flow per pipe; 600 C front pipes, 430 C cat-backs; extra K 0.2 per 90 deg bend.
5. Loss coefficients, masses and every rate in the quote are EXAMPLE VALUES typed for this demonstration.
6. The quote lists tube, library parts and labour; collectors, X-pipe, head flanges and hangers are not in it.

Stratal CAD

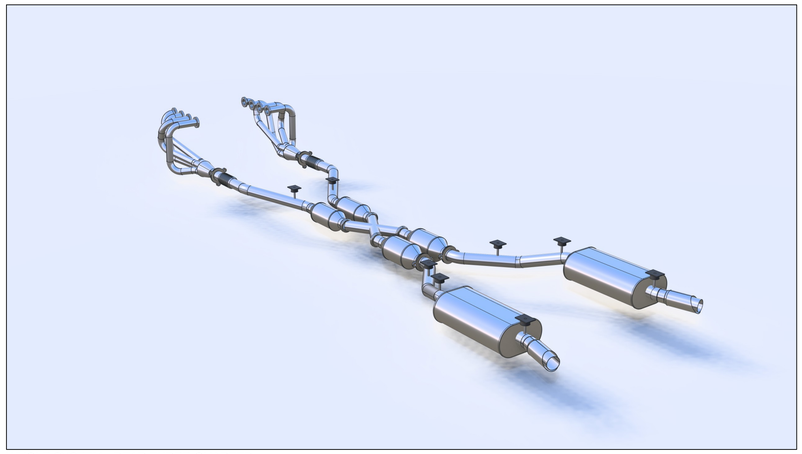
cad.stratal.co.uk

TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
HANGERS, GAS FLOW, QUOTE AND SYSTEM REPORT

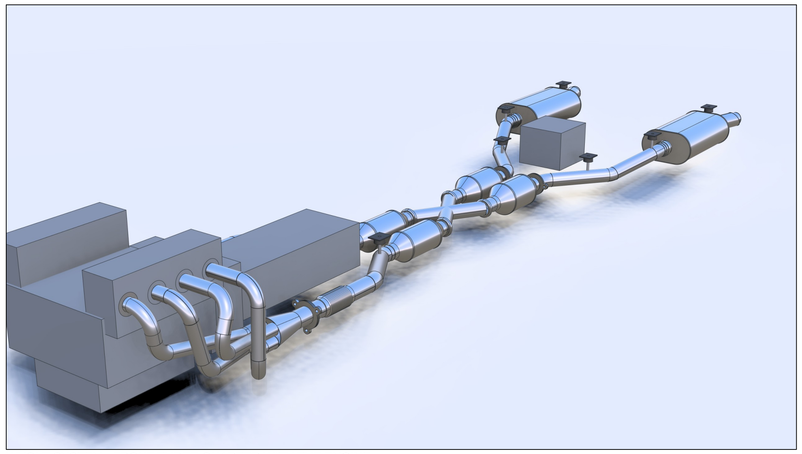
PROJECT	DRAWN		
Harcourt GT8 twin exhaust, job REF-2611	Stratal CAD demo		
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-006	6 of 7	1:5	A1
SOFTWARE		DATE	
Stratal CAD 0.1.8, Exhaust Designer 1.3.0		12 Nov 2026	

STATUS
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE

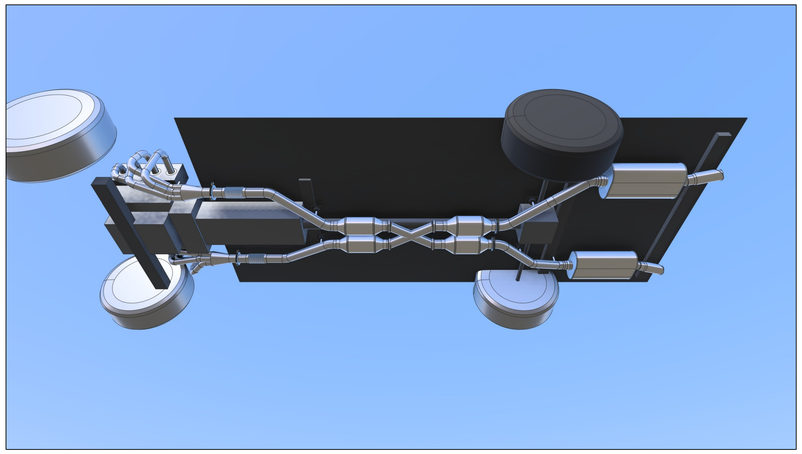
RENDERS FROM STRATAL CAD'S ILLUSTRATION RENDERER (RENDERSTILL), UNEDITED. TUBE AND PARTS ARE THE PLUGIN'S SOLIDS.



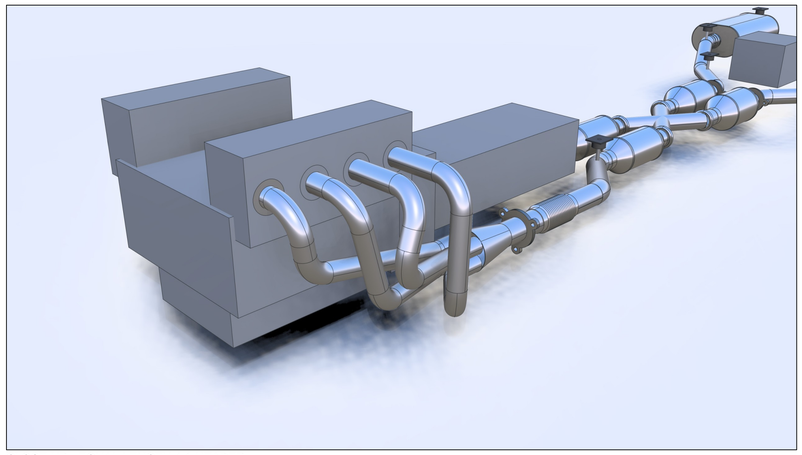
WHOLE SYSTEM - REAR THREE-QUARTER



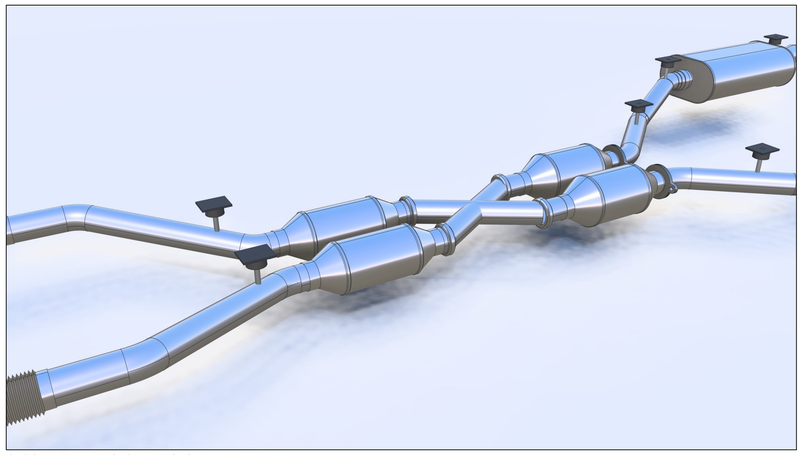
WHOLE SYSTEM - FRONT THREE-QUARTER WITH THE ENGINE



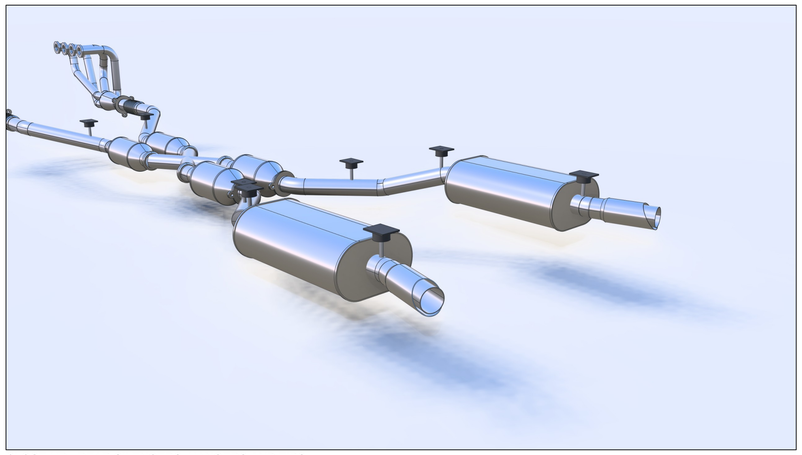
UNDERSIDE - IN THE GENERIC CHASSIS



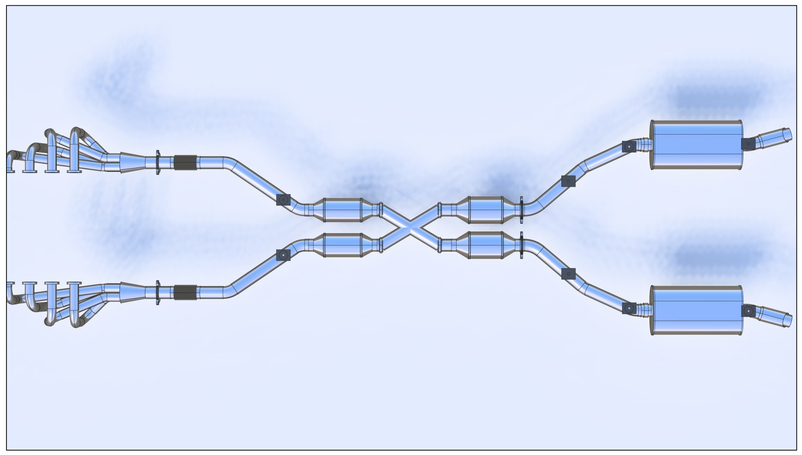
CLOSE-UP - EQUAL-LENGTH 4-1 HEADER



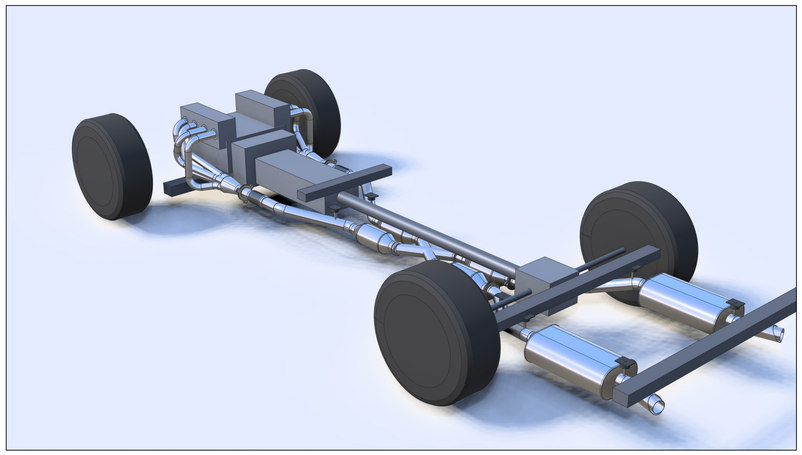
CLOSE-UP - FLEXIS, CATALYSTS AND X-PIPE



CLOSE-UP - REAR SILENCERS, HANGERS AND TIPS



FROM ABOVE



IN THE CAR - REAR THREE-QUARTER, FLOOR HIDDEN

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TITLE
TWIN 63 MM STAINLESS EXHAUST, 4-1 HEADERS
3D VIEWS

PROJECT		DRAWN	
Harcourt GT8 twin exhaust, job REF-2611		Stratal CAD demo	
DRAWING NO.	SHEET	SCALE	SIZE
STR-EXH-007	7 of 7	As noted	A1
SOFTWARE		DATE	
Stratal CAD 0.1.8, Exhaust Designer 1.3.0		12 Nov 2026	

STATUS
DEMONSTRATION DRAWING - NOT FOR MANUFACTURE