THE UNIVERSITY OF WARWICK

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Premium Automotive Research & Development Programme

Best Practice guide to checking fixture specification and procurement

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Craftsmanship Project team

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Contents

Best practice guidelines for fixture procurement

Introduction

The following guidelines have been derived from a number of relevant sources within the automotive industry, including OEM and tier 1 component/system suppliers, and specialist gauging media suppliers. Specialists from Jaguar Land Rover Gauging Media department, Collins & Aikman Automotive Ltd. (Elmdon and Stourport sites), and Visioneering Ltd., NPL Technologies and Design Services (Engineering) Ltd. have all been consulted regarding fixturing specification and procurement, and this document attempts to present a balanced and informative view of the subject area.

The intention of these guidelines is to break the procurement process into a number of logical stages which can be followed in a clear order. It is also intended that the process should be easily visualised and not require the reading of long, theoretical reports. Flow diagrams and other illustration will, therefore, be used wherever possible, and check lists will be created in order to help the relevant engineers monitor and assess progress during the procurement process.

Acknowledgements

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Robin Ridley, General Manager	Design Services (Engineering) Ltd.
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In addition to these individuals, thanks goes to the staff of Visioneering Ltd and the staff of Collins & Aikman Automotive Ltd, Elmdon and Stourport-on-Severn sites, who have assisted with the reviewing process. Finally, thanks also goes to Jaguar Land Rover Gauging Media department, whose staff have generously shared fixturing knowledge and information.

3 Stages of Fixture procurement

The procurement process can be divided into 3 basic but important consecutive stages, as follows:

1. Vendor Selection
2. Gauge Design
3. Gauge Manufacture

The importance of the first stage – vendor selection – should not be overlooked, as the capability of the gauge maker in both the design and manufacturing stages will be critical in achieving the desired fixture specification. In order to determine the suitability of possible gauge makers, the requirements to be place on the fixture must

be fully understood and minimum (and preferred) standards must have been set in advance. The prospective vendor can then be assessed against a list of criteria and detailed quotes can be requested.

Following the vendor selection process, the gauge design stage requires considerable collaboration between gauge maker and component manufacturer. The component manufacturer must provide all of the relevant and necessary information to the gauge maker, including CAD drawings with locator positions and measurement points, and must clearly specify generic requirements. The two parties must then work together to determine the final specification in order that the gauge maker can design a solution which can be bought-off by the component manufacturer prior to the start of manufacture.

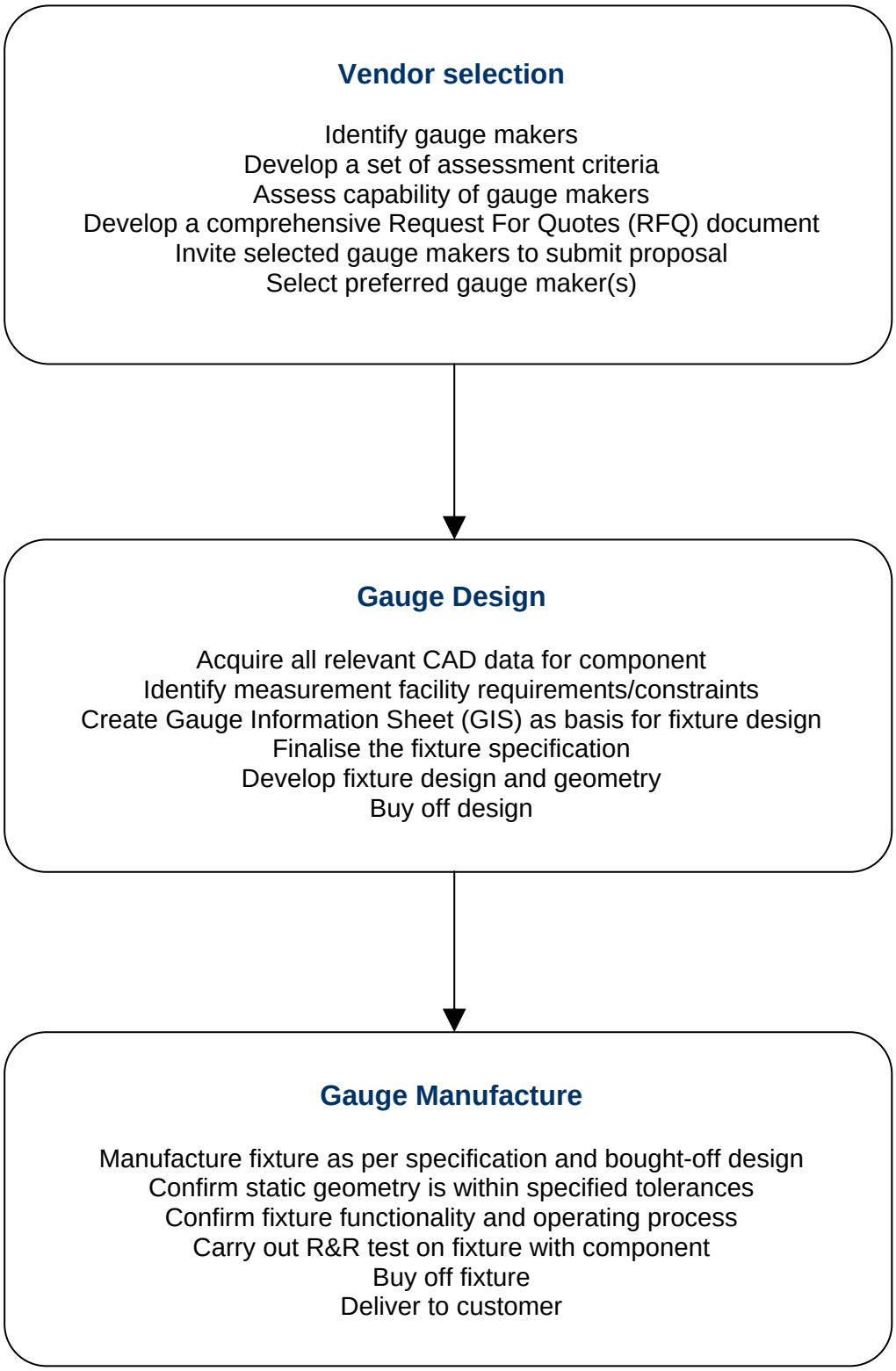
The final stage of the procurement process is the manufacturing stage, which is predominantly the responsibility of the gauge maker, with reviews being carried out by the component manufacturer at set periods within the stage. This is concluded with a thorough functional and dimensional buy-off process, performed at the gauge maker before the fixture is shipped. The buy-off process is particularly important in identifying and resolving problems with the fixture as early as possible, although if the earlier stages are performed in a disciplined manner, the buy-off process should be relatively trouble-free.

As with all process guidelines, it is all very well creating a document which describes an ideal situation, but if those guidelines cannot realistically be applied to existing facilities and resources, the document becomes worthless. Furthermore, if the guidelines are not clearly laid out and explained, again the document will not be used.

The guidelines resulting from this research will, therefore, make realistic assumptions of facilities and resources based on research with automotive trim suppliers, and will be laid out in a clear format, utilising flow charts to describe processes and diagrams to illustrate important concepts. In addition, detailed check lists will be created in order to aid self-assessment and help monitor progress throughout the procurement process.

The first flow chart, shown on the following page, gives an overview of the entire procurement process and allocates responsibilities for each stage. The individual aspects of each stage are then developed in more detail on subsequent pages, along with the self-assessment check lists described above.

Overview of Procurement Process



Vendor Selection

Vendor selection is an important part of the procurement process which is often overlooked in favour of simply selecting the gauge maker who supplied the last set of fixtures, or taking the cheapest of two or three quotes (at a stage where specifications are vague and many critical requirements are yet to be defined). Despite increasing pressures on cost, initial selection decisions must be based on the capability of the vendor to deliver. Once capability has been established, costs can then be negotiated. The vendor selection process and timescale are defined on the following page.

Described below are the critical components that make up the specified selection process. From this information the customer can perform a comprehensive selection process and assess the progress, with the help of the self-assessment check list which follows the process diagram.

Identify Gauge Makers

This initial step in the process involves the identification of potentially suitable gauge makers. The resulting search should not be limited to the local area or even region of the country, although logistics may be a criteria against which the vendor will be assessed, and a range of companies should be sought, from small scale pattern makers to large scale specialist jig and fixture manufacturers.

Even at this early stage, communication with these companies is important in order to understand the types of product and service offered prior to arranging visits for assessment purposes. Discussions with OEM Supplier Technical Assistance engineers should also be held as they are likely to know of a number of suitable gauge making companies and their assessment and approval may be required if new gauge makers are to be considered.

Initial assessment of capability

In order to create an initial shortlist of suitable gauge makers, a basic assessment of fundamental competencies, which can be broken down into two areas:

- Design capability (hardware/software and staff knowledge/experience).
- Manufacturing capability (equipment, tolerances, capacity and staff skills).

The design capabilities of the gauge maker include their CAD hardware and software, and their staffs' ability to use it to its full potential. It also includes the company's knowledge and experience of gauge making, which may be harder to assess at this early stage but which is also important as it may restrict their ability to select the most appropriate fixturing solution.

Manufacturing capability addresses the subjects of machine characteristics (speed, accuracy, flexibility etc.), tolerances that can be achieved, shop floor capacity and operator ability and experience.

Wherever possible, visits to the gauge makers should be made, in order to assess their facilities and to see examples of their work. It may also be possible to get references from other customers of the gauge makers and these will also help to get an overall picture of the company. From initial communications and site visits, a shortlist of suitable gauge makers should be compiled.

Create Request for Quotations document and distribute to short-listed vendors

At this stage, a basic specification for the required fixture(s) must be drawn up for the short-listed vendors to quote against. This may be difficult to produce as there may be certain features of the component which have not been finalised, but there are different approaches which can be taken, depending on the circumstances.

1. Create a detailed specification, based on certain assumptions, and invite all short-listed vendors to quote on a like-for-like basis, in the knowledge that the specification and hence costs are likely to change. This approach identifies the cheapest vendor for a given job, but not necessarily the most capable.

This option is the most preferable as the more detail specified, the more likely the quotation is to be accurate and the possibility of misunderstandings between customer and gauge maker is reduced. It is, however, dependent on the customer having the knowledge, experience and ability to create a thorough and accurate fixture specification, which may not necessarily be the case.

2. Deliberately leave the specification for the fixture vague and ask the short-listed vendors to offer what they consider to be the best solution(s). This approach shows more of the technical ability and experience of the vendor, but gives less indication of relative costs.

The second option may be more appropriate if the customer has little knowledge of specifying fixtures but will require early engagement with the gauge maker(s) and good communication. There is also a risk that the better, more experienced gauge makers will provide a detailed but more expensive quote whereas less experienced vendors may offer a lower quote which fails to take account of certain necessities which will add cost at a later date. A thorough and detail quotation document will therefore be very important.

3. Depending on the similarity of the component in question to previous products, it may be possible to base the requirements of the quote around an existing product and associated fixture, with all known and predicted differences being highlighted or specified wherever possible. This approach may help to save time, providing an existing product and specification to quote against at a time when the new component may not have been fully specified, but future variations in specification and cost will have to be allowed for.

This option is dependent on having a good fixture and corresponding specification document from a closely related component. If this situation exists then there is potential to save considerable time and resources and this may be increased if the same gauge maker is used. It is important that all variations in the component and fixture requirements, however small, are identified and incorporated into a new/modified specification document.

Critical aspects of the fixture design which should be included in the RFQ document, as part of the fixture specification, are listed in Appendix II. It should be remembered that the more information that is contained within the RFQ document, the more accurate the quote is likely to be and the lower the possibility of important details being overlooked and the risk of subsequent cost increases.

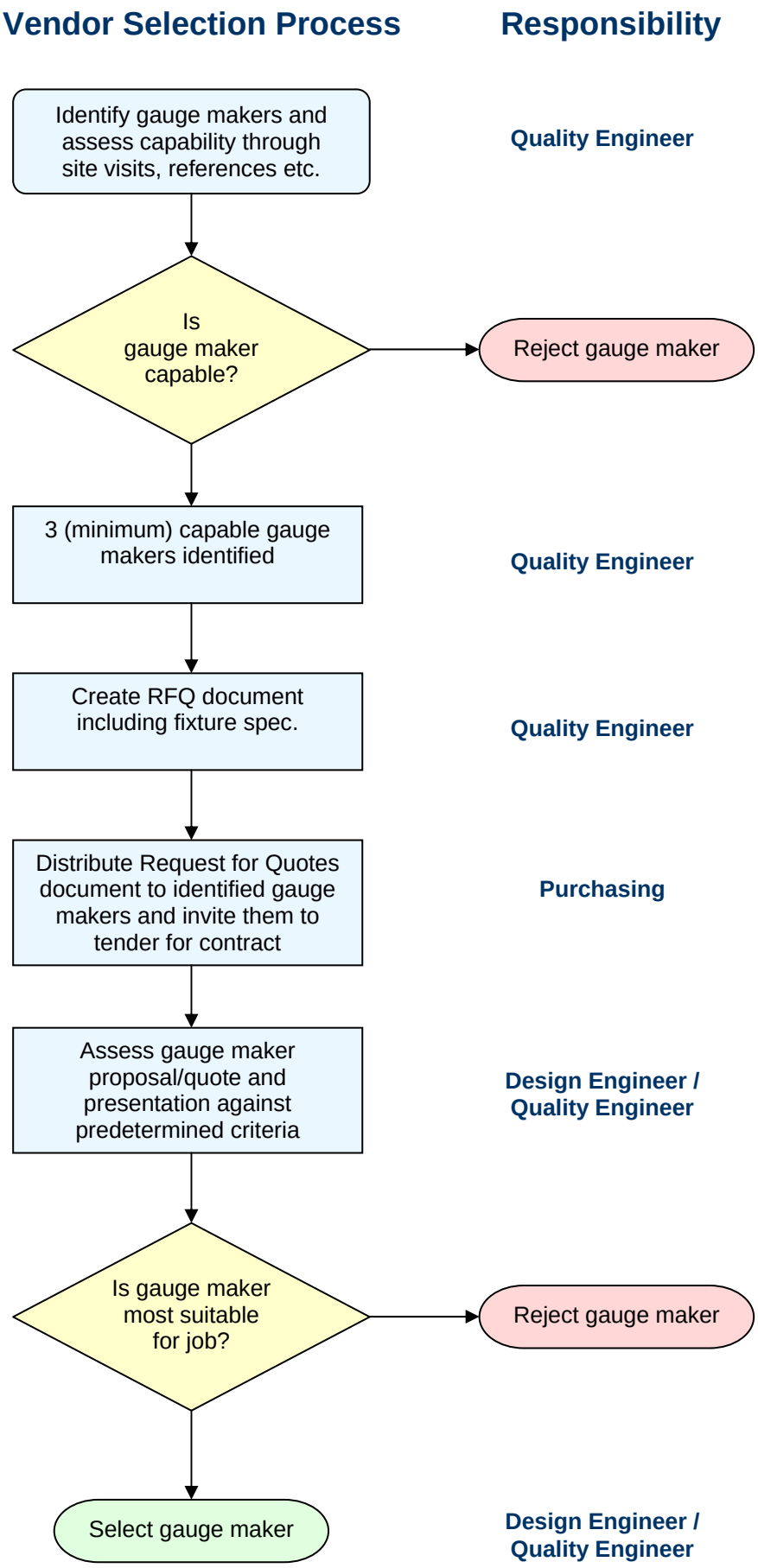
The requirements for the short-listed vendors must then be compiled into an official document, including the specification to be quoted against and the format that the response should take. Once complete, the Request for Quotes packs should be distributed to all gauge makers on the short-list. Regardless of the approach taken to drawing up the RFQ document, it should break down the requirements to be quoted against as far as possible in order that quotations from different companies can be compared like-for-like and cost differences can be identified for negotiation.

Select vendor

The critical requirement in the selection process is that the customer has a clear set of prioritised selection criteria, which must be fulfilled by the potential vendor and an order of priority for these identified criteria. Ideally the selection panel should have a good knowledge of fixturing, from location and clamping theory, through ergonomics and usability, and beyond, but it is recognised that this will not always be the case. A check list of pre-determined and prioritised assessment criteria has therefore been created as a structured assessment tool, as can be seen in Appendix I. This can be used to identify areas of significant importance when selecting a gauge maker and to supplement the existing knowledge of the customer.

A further area, which is not directly related to the gauge makers' ability but which should also be considered prior to selection, is the vendor's predicted work load and capacity over the duration of the project, with particular attention to key milestones and delivery date(s). Any potential risks to the specified delivery date(s) must be identified and suitable contingencies drawn up.

Once the selection process has taken place and a suitable vendor chosen, an initial agreement should be signed up to by both parties, stating relevant specifications and statements of work to the highest level of detail available at that point in time. It must, however, be understood by both customer and vendor that further changes to specification are likely if not inevitable and the way in which these subsequent changes are to be communicated and managed must also be defined and agreed.


Vendor Selection Process
Responsibility
Identify gauge makers and assess capability through site visits, references etc.
Quality Engineer
Is gauge maker capable?
Reject gauge maker
3 (minimum) capable gauge makers identified
Quality Engineer
Create RFQ document including fixture spec.
Quality Engineer
Distribute Request for Quotes document to identified gauge makers and invite them to tender for contract
Purchasing
Assess gauge maker proposal/quote and presentation against predetermined criteria
Design Engineer / Quality Engineer
Is gauge maker most suitable for job?
Reject gauge maker
Select gauge maker
Design Engineer / Quality Engineer

Vendor Selection Process Check List

Specify fixture(s):	**Yes**	**No**
Determine functional requirements of fixture		
RFQ document generated and fixture requirements clearly specified *		
Identify potential gauge makers:	**Yes**	**No**
3+ gauge makers identified		
Initial visits to identified gauge makers completed		
Unsuitable vendors (if any) identified and rejected		
Distribute RFQ to all suitable gauge makers identified		
Assess suitability of gauge makers:	**Yes**	**No**
Attend presentations and discussions with prospective vendors		
Assess vendors against pre-determined criteria **		
Officially notify preferred vendor		
Sign up preferred gauge maker:	**Yes**	**No**
Draw up and sign (both parties) contract incl. updated spec. and Statement of Work (SOW)		

* See Appendix I

** See Appendix II

Gauge Design

Having selected a suitable vendor, the fixture(s) must now be specified in full detail and designed. It is important that the gauge maker and customer work closely at this stage and good communication is critical. The customer must clearly specify its requirements and priorities, and the gauge maker will require detailed CAD data (which must be available at the appropriate time to avoid delaying the design process), including locator and measurement strategies, and must communicate its capabilities with regard to the customer's requirements. Finalising the fixture specification and design should not be performed by either party in isolation and once a design has been developed, a formal sign-off process should then be followed in order to document the agreement between customer and vendor. It is not uncommon that the individual(s) tasked with procuring fixturing within a company will not be the end user and it is therefore important that the specific end-user(s) of the fixturing is involved in the design sign-off process to ensure that the functionality and usability of the proposed design are acceptable.

Acquire all relevant CAD data and associated information for component

This will include the basic CAD file with full dimensioning and tolerances, and the accompanying measurement point, cut plane and locator file(s) which will help determine the measurement strategy and, hence, the positioning of clamps and locators on the fixture. It is the customer's responsibility to provide this data to the gauge maker. It should be noted that it may be either the component supplier or the vehicle manufacturer that determines the measurement points for the component in question, but in either case the gauge maker may have to ask specifically for the information as it will not necessarily be contained within/attached to the CAD file. This is important in order that access to measurement points is not impaired by the fixture structure or clamps.

It may also be useful at this stage to be aware of component or fixture issues relating to previous derivatives of the component, in order that particular features can be incorporated into the fixture, such as mating surfaces and interfaces. Audit reports may be the best source of this information.

Identify any customer measurement facility requirements

A critical consideration often overlooked is the requirements of the measurement facility, in particular the dimensions of the measurement device and its operating envelope. If portable measurement arms are to be used, allowances must be made for them to attach to the fixture base and datums must be positioned within their reach.

Maximum weight may be an issue for larger fixtures and the type of lifting/transporting device available, be it gantry crane, forklift truck, basic trolley etc. must also be taken into consideration. Lifting and handling requirements must, therefore, also be agreed at the design stage and lifting eyes, fork tubes or hand grips incorporated as appropriate.

Develop fixturing concept – The Gauge Information Sheet (GIS)

Concept designs for the proposed fixturing should be developed and presented by the gauge maker early on in the design stage in the form of a Gauge Information Sheet (GIS). This will ensure that the customer is happy with the direction of the work and is also an opportunity for any issues arising or not covered in the specification to be identified and addressed. The concept design would be expected to include details of part orientation to base plate, clamp type and sequence, locator pins and measurement points. The contents of a GIS are described in Appendix IV, and a sample GIS is shown in Appendix V, along with the subsequent detailed gauge design.

Finalise fixture specification and other related documentation

Although the majority of the fixture specification will have been included in the RFQ document, subsequent engineering changes to the component(s) in question and the development of a specific measurement and location strategy will have to be added to the original specification as they become available/are finalised. An initial change cut-off date will also need to be set, from which point the detailed machining/setting of the fixture(s) can commence. Beyond this date, a change management process, as agreed between customer and vendor, will come into operation and variations to project cost and timing will have to be addressed

Develop fixture design and geometry

Having developed a detailed design specification, the fixture is then designed to this specification with a structured review process running in parallel to identify and address any issues arising. Regular reviews help to facilitate the communication and resolution of any problems that may occur during the design process and prevents unwelcome surprises on the part of the customer later on when the fixture is fabricated.

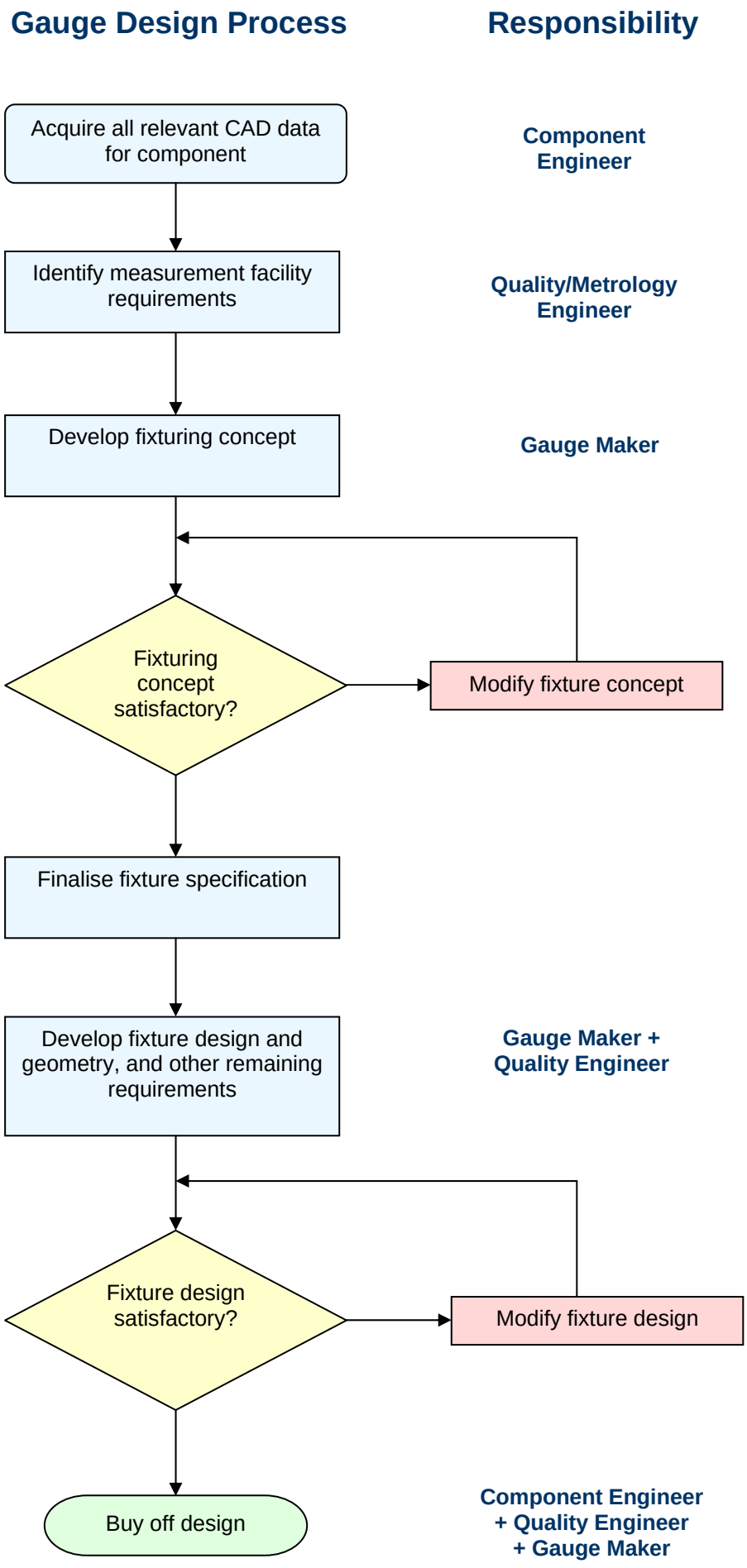
Further considerations

In addition to the primary functions of the fixture, other considerations such as health and safety, storage, transportation and durability must be incorporated into the overall design, and important information including the gauge identification markings, weight of assembly and datums and their co-ordinates should be clearly labelled on the fixture.

A set of recommendations has been developed to address the features and characteristics which should be considered during the fixture design process. This is intended to be a generic but comprehensive list against which both the specification and design can be checked.

Buy off design

Having been involved in regular reviews, the customer will have a good understanding of the fixture design when finished and will be in a good position to buy off the design, safe in the knowledge that it will fulfil its requirements when manufactured. The buy off process should centre on the production of a fully detailed Gauging Information Sheet (GIS), which illustrates all location points and pads, the loading and clamping sequence, and the co-ordinates of all critical points. Associated documents will also include details of the clamps, base plate, datums, eye-bolts etc., and the relevant level of CAD/component data on which the fixture design is based. Further details of the buy off requirements are detailed in the design check list in Appendix II.


Gauge Design Process
Responsibility
Acquire all relevant CAD data for component
Component Engineer
Identify measurement facility requirements
Quality/Metrology Engineer
Develop fixturing concept
Gauge Maker
Fixturing concept satisfactory?
Modify fixture concept
Finalise fixture specification
Develop fixture design and geometry, and other remaining requirements
Gauge Maker + Quality Engineer
Fixture design satisfactory?
Modify fixture design
Buy off design
Component Engineer + Quality Engineer + Gauge Maker

Gauge Design Process Check List

Acquire/arrange access to component data:	**Yes**	**No**
CAD file(s)		
Measurement point and cut plane data		
locator types and positions		
Working environment constraints:	**Yes**	**No**
Maximum dimensions identified		
Maximum weight identified		
Transportation and storage requirements identified		
Supplier agreement documentation:	**Yes**	**No**
Fixture specification defined		
Supplier/customer statement of work developed		
Project timing plan determined		
Fixture design:	**Yes**	**No**
GIS* generated and presented to customer		
Fixture design meets functional requirements		
Fixture design meets health and safety requirements		
Fixture design meets transportation and storage requirements		
Sign-off process:	**Yes**	**No**
Fixture design acceptable		
Fixture design officially signed off		

* See Appendix IV

Gauge Manufacture

With the fixture design bought off, the manufacturing stage can commence. It is not uncommon that delays in data release and late engineering changes will have put the project behind schedule, and it is critical that any changes are efficiently managed. Regular review meetings between customer and gauge maker are important to monitor progress and address issues arising. Whilst, in an ideal world, all of the necessary data would be available prior to the start of manufacture, late and changing data will inevitably occur and the customer must accept that this will have an impact on the timing and cost of the job.

Manufacture fixture as per specification and bought-off design

Following the detailed and structured design process, the manufacturing of the fixture should be a relatively straightforward procedure, although the likelihood of engineering change to the component means that the review process implemented in the design stage should be carried over to the manufacturing stage.

The review process should be used as a two-way communication tool, allowing manufacturing difficulties and proposed modifications to be highlighted by the gauge maker, and any component and functionality changes to be raised by the customer. Engineering changes to the component, cost and timing implications, and any other issues arising should be logged electronically in some form of data tracker.

Confirm static geometry is within specified tolerances

Whilst the manufacturing of the fixture is largely the responsibility of the gauge maker alone, there will be a lengthy buy-off process in which the customer must take a leading role, and this will start with the basic geometry of the fixture. A measurement report must be provided by the gauge maker and certain measurements from this report should be confirmed with the customer present prior to shipping the fixture. It is suggested that this report includes all pad and pin positions (five points each), and a sample of points on gap/flush/form bars.

Confirm fixture functionality and operating process

Functionality and operating process should also be documented in a report and again demonstrated to the customer prior to shipping. This will include the ability to hold and accurately locate the component without impeding measurement points/paths, the clamping sequence and if specified, convert from a gap and flush checking medium to a CMM holding fixture.

Carry out R&R test on fixture with component

Finally, a type 1 R&R study must be performed by the gauge maker, in order to demonstrate that the fixture is capable. This can only be carried out reliably,

however, if suitable components are available for inspection, and this can result in considerable time pressure being placed on the final stages of the manufacturing and buy-off processes. The component(s) used for the study do not need to be off-tool, but must be of adequate accuracy that there are no clashes with the fixture and, of critical importance, the locator holes are correctly positioned and not oversized. Careful time management is, therefore, very important, with the fixture being ready in time for the first off-tool parts and the R&R study subsequently being performed as quickly as possible.

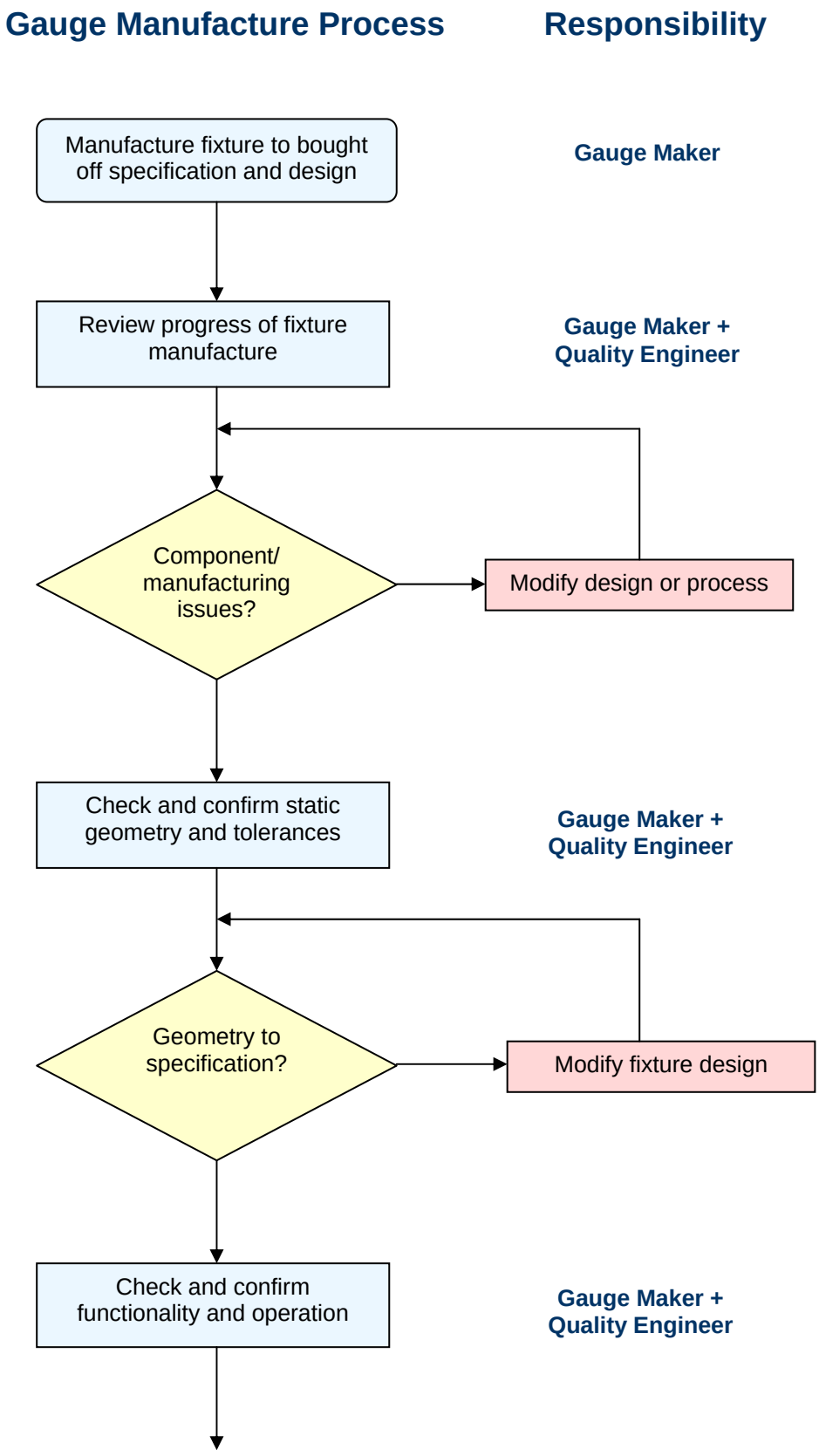
The details of this study should include a loading/unloading procedure, clamping sequence and measurement programme for the measurement device specified by the customer (this may have to be developed in collaboration with the customer)

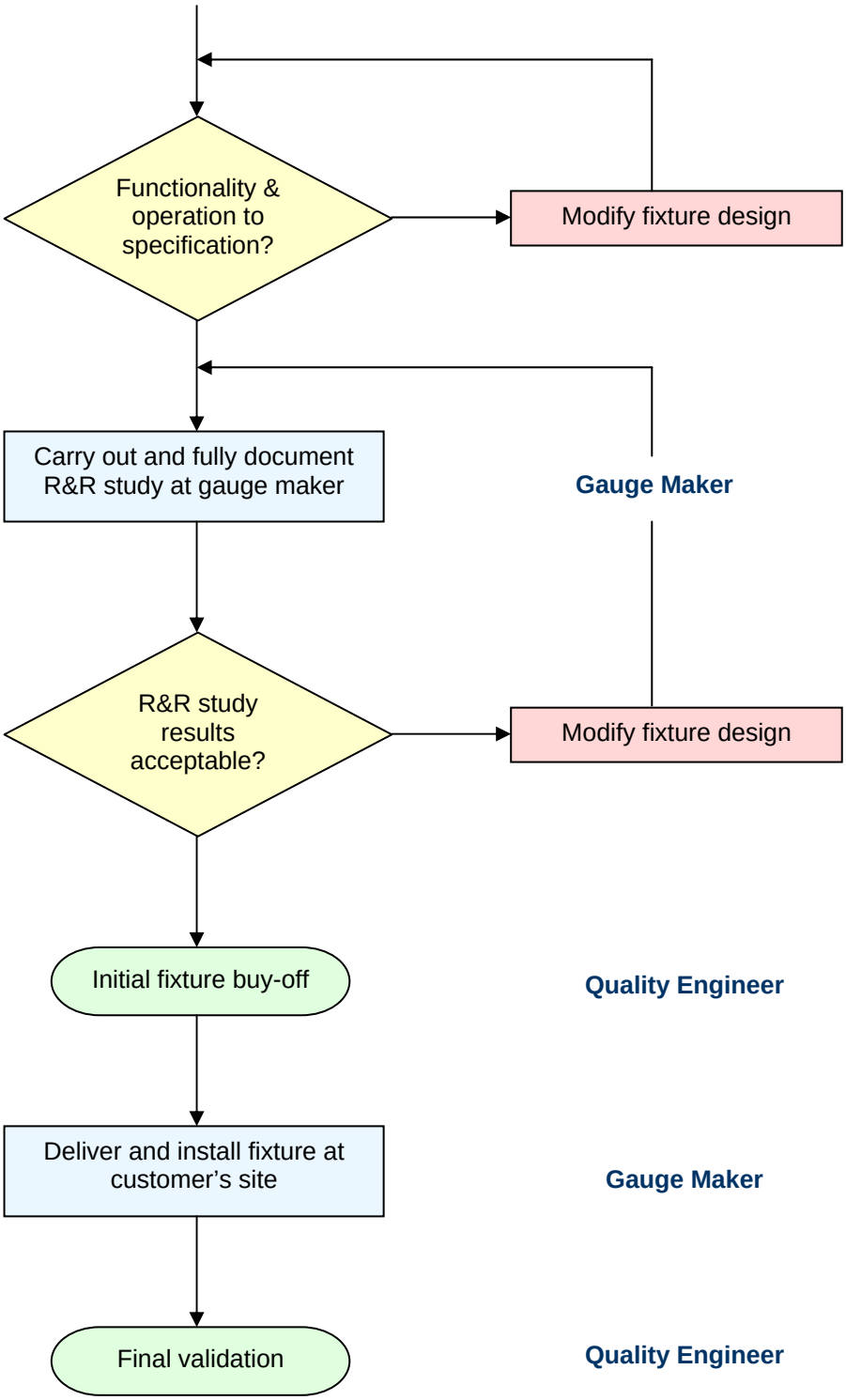
Buy off fixture

Once the above checks have been approved by the customer, the fixture is then bought off and hence approved for shipping to the customer's site. The buy off pack provided by the gauge maker should include inspection reports, R&R study, GIS, component level of CAD data used (stamped on the fixture), calibration certificates for the inspection equipment used and the filled in check list supplied by the customer.

Deliver to customer

The delivery process should include the delivery and installation of the bought off fixture and a secondary, more basic buy off procedure must be followed to ensure that the fixture has not been damaged in transit and that the measurement programme (if applicable) runs correctly on the customer's measurement equipment. This will include a functional and dimensional check once the fixture has been installed and may also include a type 2 R&R study, depending on OEM requirements. The process must be fully supported by the gauge maker and only when the fixture is fully installed and operational should it become the responsibility of the customer.


Gauge Manufacture Process
Responsibility
Manufacture fixture to bought off specification and design
Gauge Maker
Review progress of fixture manufacture
Gauge Maker + Quality Engineer
Component/ manufacturing issues?
Modify design or process
Check and confirm static geometry and tolerances
Gauge Maker + Quality Engineer
Geometry to specification?
Modify fixture design
Check and confirm functionality and operation
Gauge Maker + Quality Engineer


Functionality & operation to specification?
Modify fixture design
Carry out and fully document R&R study at gauge maker
Gauge Maker
R&R study results acceptable?
Modify fixture design
Initial fixture buy-off
Quality Engineer
Deliver and install fixture at customer's site
Gauge Maker
Final validation
Quality Engineer

Gauge Manufacture Check List

Manufacturing process:	**Yes**	**No**
Design agreed and bought off by customer and vendor		
Timing of manufacturing process planned and agreed		
Change management process agreed		
Fixture review sessions scheduled		
Fixture review process during delivery:	**Yes**	**No**
Reviews carried out and fully documented		
Issues and change requests agreed by both parties		
All lessons learned fully documented		
Fixture buy-off process:	**Yes**	**No**
Static geometry check carried out and report issued		
Functionality and operating process demonstrated and documented		
Type 1 R&R study performed and report issued		
Delivery and installation:	**Yes**	**No**
Fixture delivered and installed at customer's site		
Basic geometry and functionality checks carried out		
Type 2 R&R study performed and report issued		
Final buy-off procedure:	**Yes**	**No**
All inspection reports and R&R studies acceptable to customer		
Gauge delivery check list* completed		
Buy-off pack** provided and approved		

* See Appendix III
** See Appendix IV

Appendix I

Recommendations for Fixture Design Specification

Recommendations for Fixture Design Specification

1. Fixture Design:

The gauge maker must create a complete 3D CAD design of the proposed fixture, in an agreed file format.

The materials selected and the structure design must be fit for purpose, and for the environment in which the gauge will be used and stored.

2. Location and Measurement:

The component should be held in car-line, particularly if it is a flexible piece of trim, to avoid any distortion due to gravity/its own weight.

The component should be held using the same locator strategy as will be the case for its fitment to the vehicle.

The cut planes for the component, as specified by the OEM/supplier, should be used to determine the measurement points and corresponding CMM measurement programme.

Measurement points and CMM measurement requirements must be determined prior to fixture design and clamp positioning to avoid clashes.

3. Datums:

The fixture must have a minimum of 2 master datums on the base plate, which must, therefore, be a machined surface.

The use of 3 master datums eliminates the need for the base to have an accurately machined surface.

Bushes are recommended for the datums, with spheres and D-pads also being suitable.

Using the edges of the base plate is not recommended as they can easily be damaged when handling/transporting the fixture.

All alignments should be taken off the master datums on the fixture base. Using "best fit" alignments should be avoided wherever possible as they do not give errors from a definitive point and exact replication cannot be achieved.

4. Form Bars and Simulators:

Form bars and simulators must be NC cut from the vehicle manufacturer's CAD data.

Gapping between form bar and component to be clearly specified – typically 3mm, occasionally 5mm, and stamped on the fixture.

If the fixture is to be used in a production environment, recommended materials are Obomodulan 1000g/m^3 or Ciba 5166.

5. Tolerances:

The following tolerances should be achieved, relative to the master datums:

Base flat/parallel (if used as datum surface)	±0.05mm
Locator net pads	±0.10mm
Locator pin positions	±0.05mm
SPC data capture bush	±0.10mm
Form bars (gap and flush measurement)	±0.15mm (0.15/400 waviness)

6. Clamping:

Clamping sequence must be determined by the gauge maker, in line with the vehicle assembly process, and clearly identified on the fixture.

Clamps should be sourced from a recognised and established manufacturer.

7. Inspection:

Inspections and R&R studies performed at the gauge maker's site should be carried out on a CNC CMM to guarantee repeatability.

Inspection reports should include a graphical illustration of the fixture, based on the 3D CAD design, with annotated measurement points.

All reports must be accompanied by a copy of the measurement machine calibration certificate.

8. Identification:

Identification plate(s) must be attached to the fixture base plate or structure and must clearly display the following information:

Part number
Part level
Tool/asset number
Weight and lifting method
Datum co-ordinates
Gap and flush measurements (if applicable)
Owner
Vendor contact details

9. Handling and Health & Safety:

Lifting and handling aids appropriate to the fixture weight and customer facilities must be provided.

Relevant safety information must be displayed clearly on the fixture base.

Suitable storage racks/tables etc. should be quoted for and provide by the gauge maker

Appendix II

Vendor Selection Check List

Vendor Selection Check List

Sample values

Assessment criteria	Criteria definition	Weighting	Score (out of 10)				Weighted score			
			1	2	3	4	1	2	3	4
Capability	Design/manufacturing ability Core competencies Historical performance	**10**								
Project management	Structure of company/project team Proposed project management strategy	**9**								
Technical solutions	Weight, transportation and ease of use Loading and clamping process simulation Understanding of functionality requirements	**9**								
Quoted cost	Costs relative to RFQ requirements Detailed breakdown of costs Cost reduction recommendations	**9**								
Change management	Plan for accommodating late changes Understanding of cost/timing implications	**8**								
Innovation	Value-added enhancements New materials/processes/technologies	**7**								
Resources	No. of employees/machines CAD system compatibility	**6**								
Quality planning	Compliant with relevant quality standards Training programme for staff	**5**								
Proposal presentation	Understanding of RFQ requirements Clarity of proposal/concept(s) Demonstration of capability	**5**								
						Total				

Appendix III

Gauge Delivery Buy-Off Check List

Gauge Delivery Buy-Off Check List

Conformance to specification:	**Yes**	**No**
Gauge conforms to GIS		
Gauge conforms to agreed design		
Gauge manufactured to appropriate part level/release		
Gauge verification:	**Yes**	**No**
Is inspection report dimensionally correct		
Is R&R study acceptable		
Datums:	**Yes**	**No**
All datums clearly identified on gauge		
Datum co-ordinates displayed adjacent to datum		
Locator pins:	**Yes**	**No**
Primary pin dimensionally and positionally correct and securely mounted		
Secondary pin dimensionally and positionally correct and securely mounted		
Clamps and net pads:	**Yes**	**No**
All clamps secured and dowelled		
Clamps do not obstruct loading operation		
Net pads of correct shape and orientation		
Clamping sequence clearly displayed		
SPC units (if applicable):	**Yes**	**No**
All SPC units/fittings accurately positioned		
All SPC units/fittings stably and robustly located		
Form bars and simulators:	**Yes**	**No**
Specified form bars and simulators provided and dimensionally accurate		
Form bars and simulators securely located and dowelled		
Gap and flush measurements clearly identified on gauge/form bar/simulator		

Gauge identification:	**Yes**	**No**
Are the following clearly labelled:		
Vehicle model number		
Component number		
Issue level		
Gauge description		
Process/instruction plate		
Gap and flush checks		
Gauge structure:	**Yes**	**No**
Gauge structure conforms to the agreed design		
Is the structure stable and robust		
Is the cosmetic finish acceptable		
Loose parts:	**Yes**	**No**
All loose parts (fixings etc.) tethered to the gauge		
All loose parts clearly labelled (including location on gauge)		

Appendix IV

GIS, Gauge Design and Delivery Buy-Off Pack Contents

GIS, Gauge Design and Delivery Buy-Off Pack Contents

The **Gauging Information Sheet** should include the following:

1. A three dimensional technical illustration of the component in question, clearly showing positions of locators and clamps, and the orientation of the component with respect to the fixture base. This illustration should also identify any important x,y,z co-ordinates with respect to the base plate.

2. Type and geometry of locator pins, clamps and net pads to be used, and the loading and clamping sequence proposed.

3. The x,y,z, co-ordinates of the locator pins and net pads.

4. Illustrations of where dti and gap and flush checks (if applicable) are to be carried out.

The **gauge design buy-off pack** should include the following:

1. The GIS, including any modifications (clearly highlighted) since it was originally drawn up.

2. A fully detailed change sheet, listing any changes since initial gauge concept buy-off.

3. The date and part level/engineering release for the component in question.

4. A Bill of Materials for the fixture, including material specifications and relevant standards.

5. A fully detailed and annotated two dimension, 3rd angle projection of the fixture (plan and front views minimum), and a three dimensional isometric view of the unloaded fixture, showing all important features including clamps, pads, locator pins, datums, identification plates, eye bolts, etc.

6. Vertical cross-sections through a locator pin, clamp and datum, showing base plate surface, risers and fixings.

7. A two dimensional plan view of the base plate, detailing all holes, threads and surface finishes.

8. Complete two dimensional manufacturing drawings for every individual part to be manufactured/assembled (excluding fixings but including clamps, locator pins and net pads).

The **gauge delivery buy-off pack** should include the following:

1. All design and manufacturing check lists, fully completed.

2. Concerns sheet detailing outstanding issues and proposed resolutions.

3. Confirmation of gauge material specifications from suppliers.

4. CMM inspection report for the fixture, including fixture geometry and gap and flush checks.

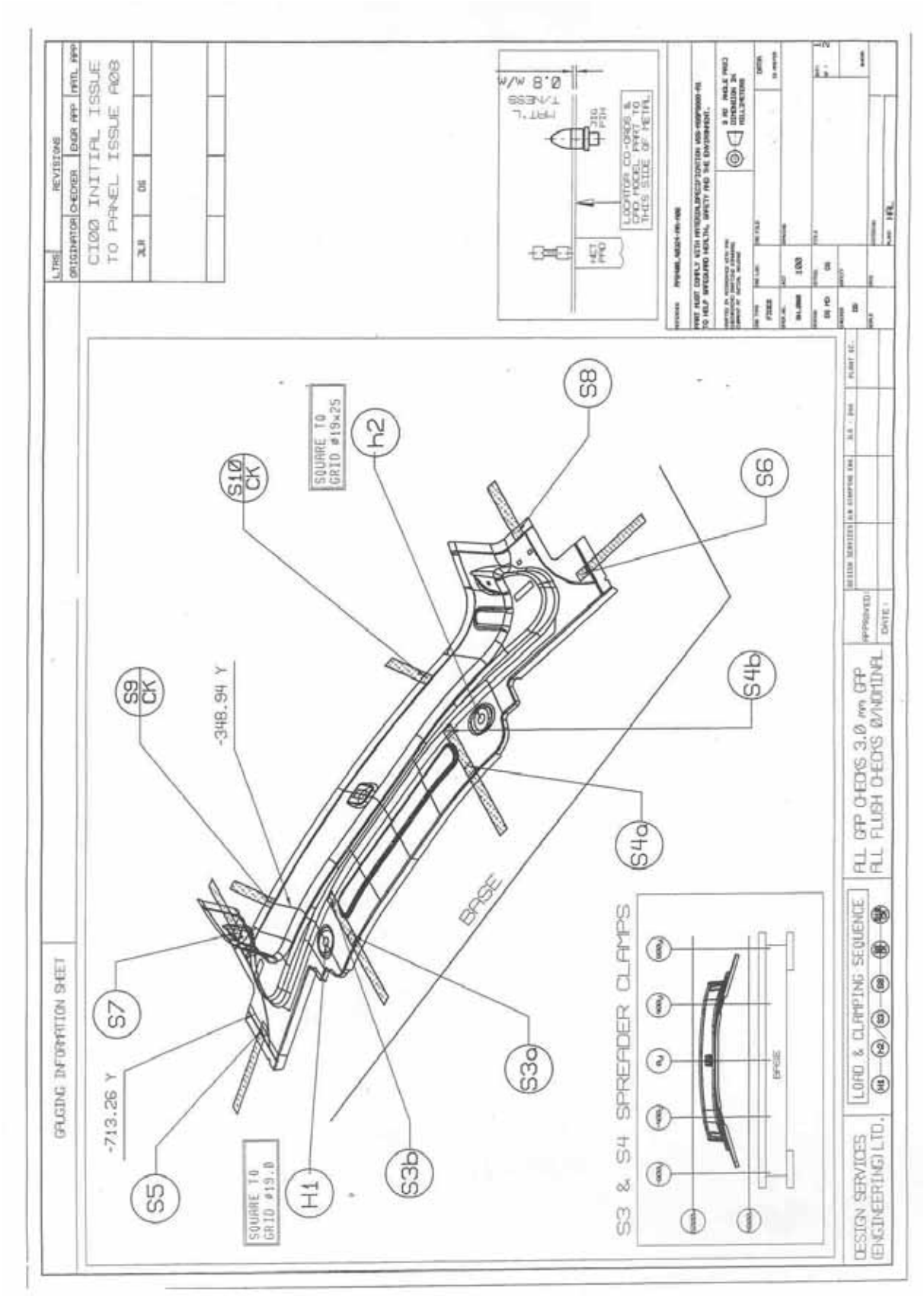
5. Type 1 R&R study report.

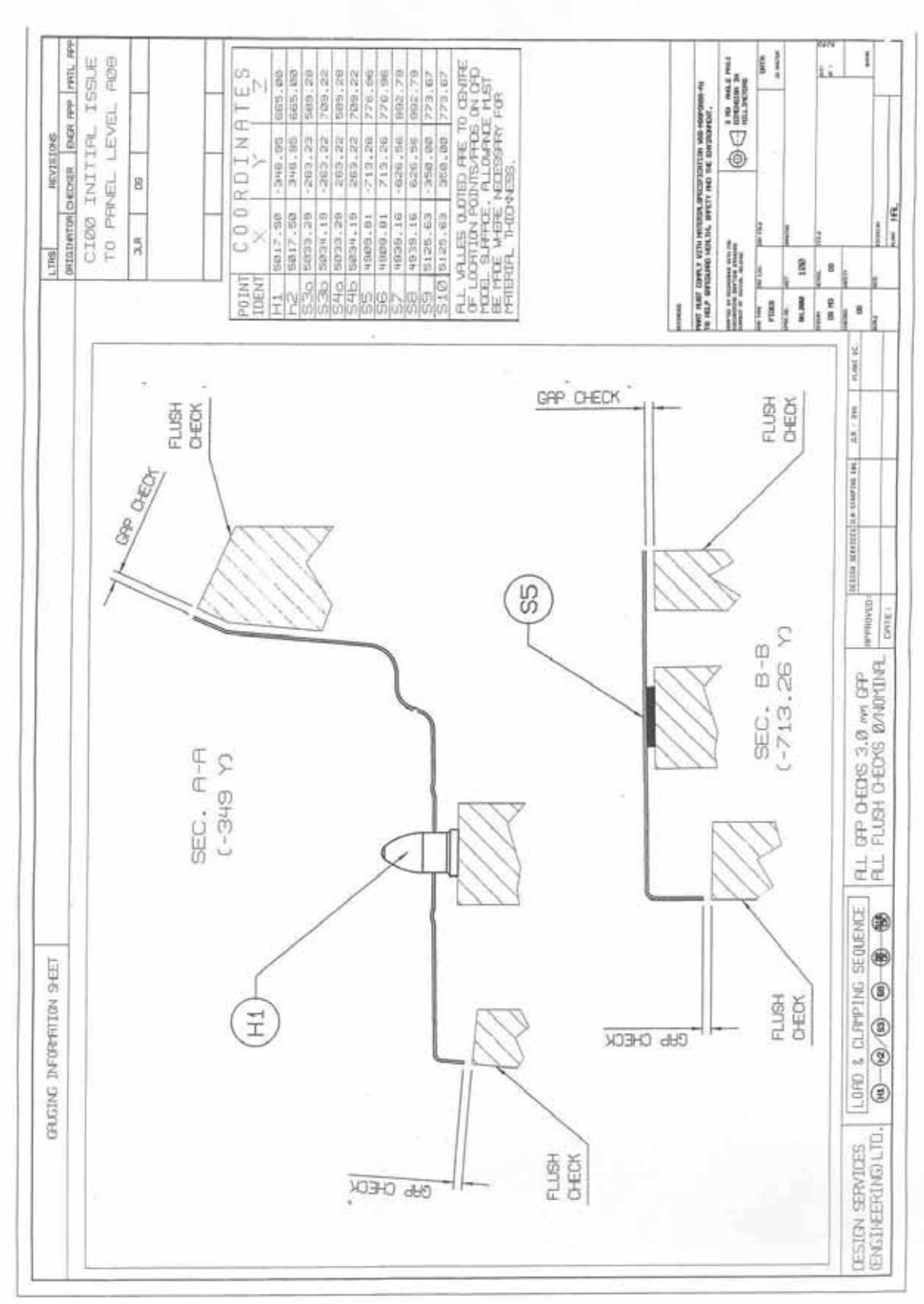
6. Calibration certificate for CMM machine.

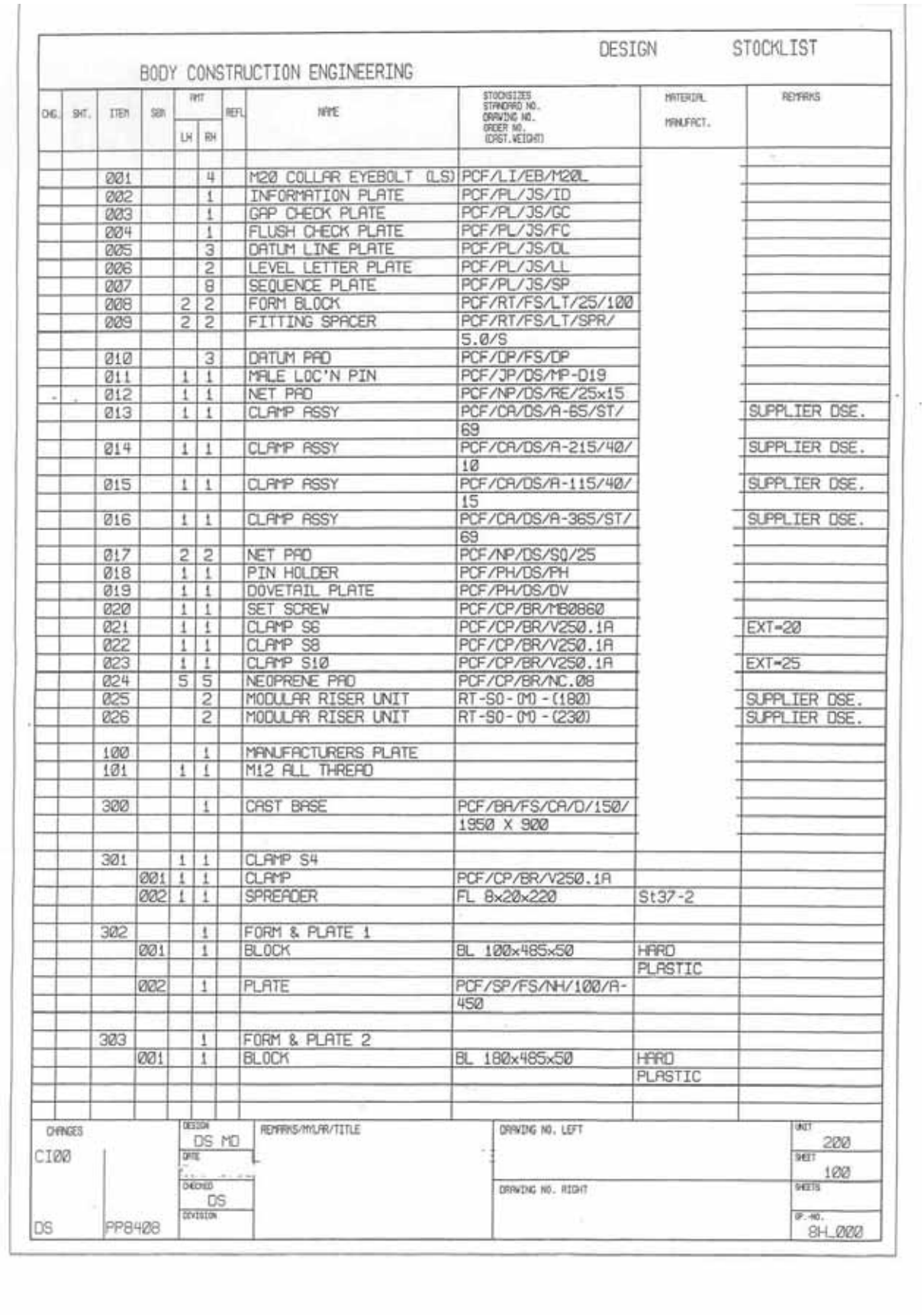
Appendix V

Sample “Gauge Information Sheet” and detailed gauge design

(Design Services (Engineering) Ltd.)


GAUGING INFORMATION SHEET
REVISIONS
C100 INITIAL ISSUE
TO PANEL ISSUE A03
S1
S2
S3a
S3b
S4a
S4b
S5
S6
S7
S8
S9 CK
S10 CK
H1
h2
-713.26 Y
-348.94 Y
SQUARE TO GRID #19.8
SQUARE TO GRID #19x25
BASE
S3 & S4 SPREADER CLAMPS
LOAD & CLAMPING SEQUENCE
ALL GAP 0±0.5 3.0 mm GAP
ALL FLUSH 0±0.5 @NOMINAL
DESIGN SERVICES
ENGINEERING LTD.


GAUGING INFORMATION SHEET
DESIGN SERVICES ENGINEERING LTD.
LOAD & CLAMPING SEQUENCE
ALL GAP CHECKS 3.0 mm GAP
ALL FLUSH CHECKS Ø NOMINAL
SEC. A-A (-349 Y)
SEC. B-B (-713.26 Y)
GAP CHECK
FLUSH CHECK
H1
S5
COORDINATES
POINT IDENT
X
Y
Z
ALL VALUES QUOTED ARE TO CENTRE OF LOCATION POINTS/PADS ON CAD MODEL SURFACE, ALLOWANCE MUST BE MADE WHERE NECESSARY FOR MATERIAL THICKNESS.
C100 INITIAL ISSUE TO PANEL LEVEL ADB

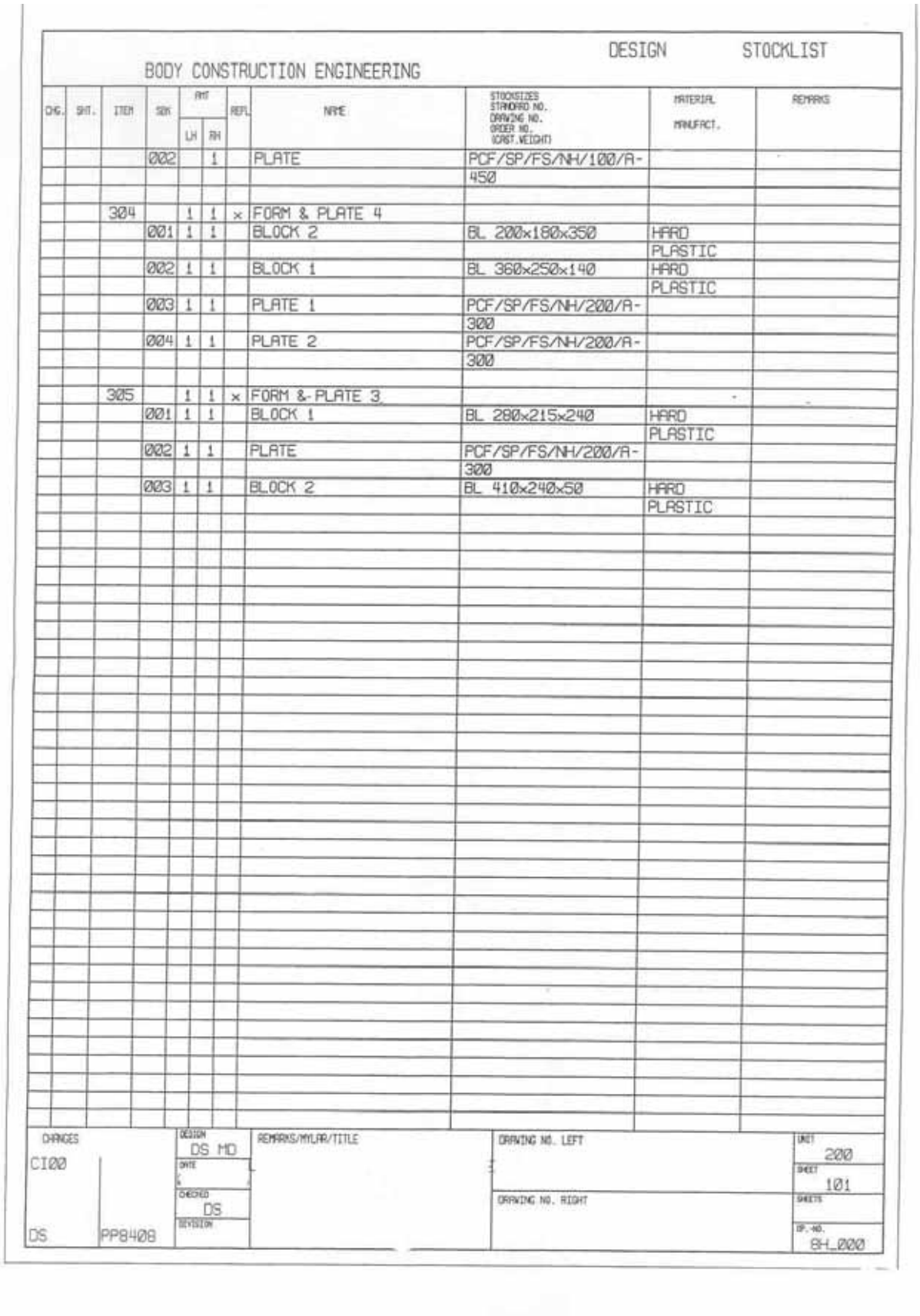


DESIGN STOCKLIST

BODY CONSTRUCTION ENGINEERING

CHG.	SHT.	ITEM	SUB	QNT LH	QNT RH	REF.	NAME	STOCKSIZES STANDARD NO. DRAWING NO. ORDER NO. (CAST. WEIGHT)	MATERIAL MANUFACT.	REMARKS
		001			4		M20 COLLAR EYEBOLT (LS)	PCF/LI/EB/M20L		
		002			1		INFORMATION PLATE	PCF/PL/JS/ID		
		003			1		GAP CHECK PLATE	PCF/PL/JS/GC		
		004			1		FLUSH CHECK PLATE	PCF/PL/JS/FC		
		005			3		DATUM LINE PLATE	PCF/PL/JS/DL		
		006			2		LEVEL LETTER PLATE	PCF/PL/JS/LL		
		007			8		SEQUENCE PLATE	PCF/PL/JS/SP		
		008		2	2		FORM BLOCK	PCF/RT/FS/LT/25/100		
		009		2	2		FITTING SPACER	PCF/RT/FS/LT/SPR/		
								5.0/S		
		010			3		DATUM PAD	PCF/DP/FS/DP		
		011		1	1		MALE LOC'N PIN	PCF/JP/DS/MP-D19		
		012		1	1		NET PAD	PCF/NP/DS/RE/25x15		
		013		1	1		CLAMP ASSY	PCF/CA/DS/A-65/ST/		SUPPLIER DSE.
								69		
		014		1	1		CLAMP ASSY	PCF/CA/DS/A-215/40/		SUPPLIER DSE.
								10		
		015		1	1		CLAMP ASSY	PCF/CA/DS/A-115/40/		SUPPLIER DSE.
								15		
		016		1	1		CLAMP ASSY	PCF/CA/DS/A-365/ST/		SUPPLIER DSE.
								69		
		017		2	2		NET PAD	PCF/NP/DS/SQ/25		
		018		1	1		PIN HOLDER	PCF/PH/DS/PH		
		019		1	1		DOVETAIL PLATE	PCF/PH/DS/DV		
		020		1	1		SET SCREW	PCF/CP/BR/MB0860		
		021		1	1		CLAMP S6	PCF/CP/BR/V250.1A		EXT=20
		022		1	1		CLAMP S8	PCF/CP/BR/V250.1A		
		023		1	1		CLAMP S10	PCF/CP/BR/V250.1A		EXT=25
		024		5	5		NEOPRENE PAD	PCF/CP/BR/NC.08		
		025			2		MODULAR RISER UNIT	RT-S0-(M)-(180)		SUPPLIER DSE.
		026			2		MODULAR RISER UNIT	RT-S0-(M)-(230)		SUPPLIER DSE.
		100			1		MANUFACTURERS PLATE			
		101		1	1		M12 ALL THREAD			
		300			1		CAST BASE	PCF/BA/FS/CA/D/150/		
								1950 X 900		
		301		1	1		CLAMP S4			
			001	1	1		CLAMP	PCF/CP/BR/V250.1A		
			002	1	1		SPREADER	FL 8x20x220	St37-2	
		302			1		FORM & PLATE 1			
			001		1		BLOCK	BL 100x485x50	HARD	
									PLASTIC	
			002		1		PLATE	PCF/SP/FS/NH/100/A-		
								450		
		303			1		FORM & PLATE 2			
			001		1		BLOCK	BL 180x485x50	HARD	
									PLASTIC	

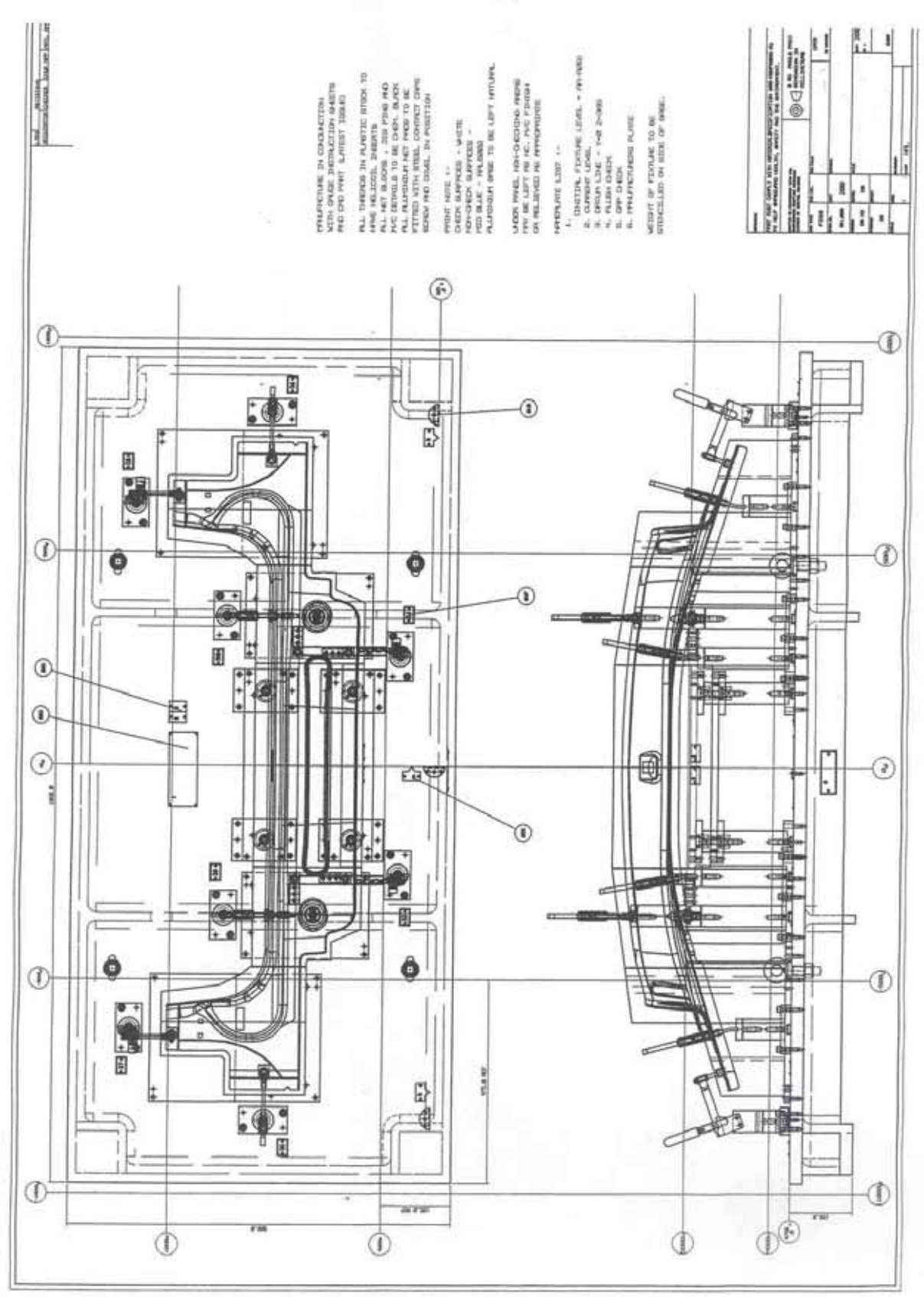
CHANGES	DESIGN	REMARKS/MYLAR/TITLE	DRAWING NO. LEFT	UNIT
CI00	DS MD			200
	DATE			SHEET
	CHECKED DS		DRAWING NO. RIGHT	100
	DIVISION			SHEETS
DS PP8408				DP.-NO. 8H_000

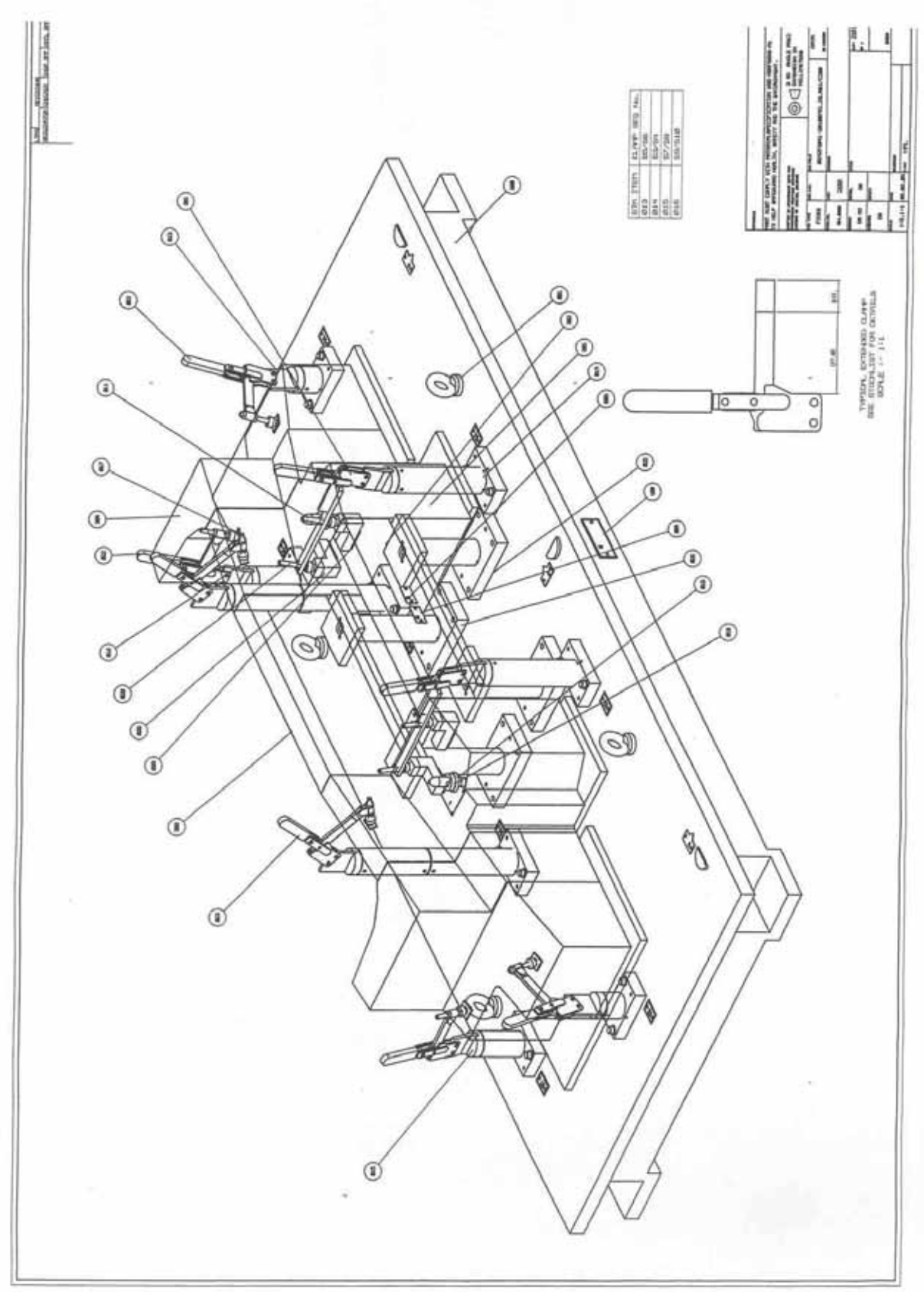


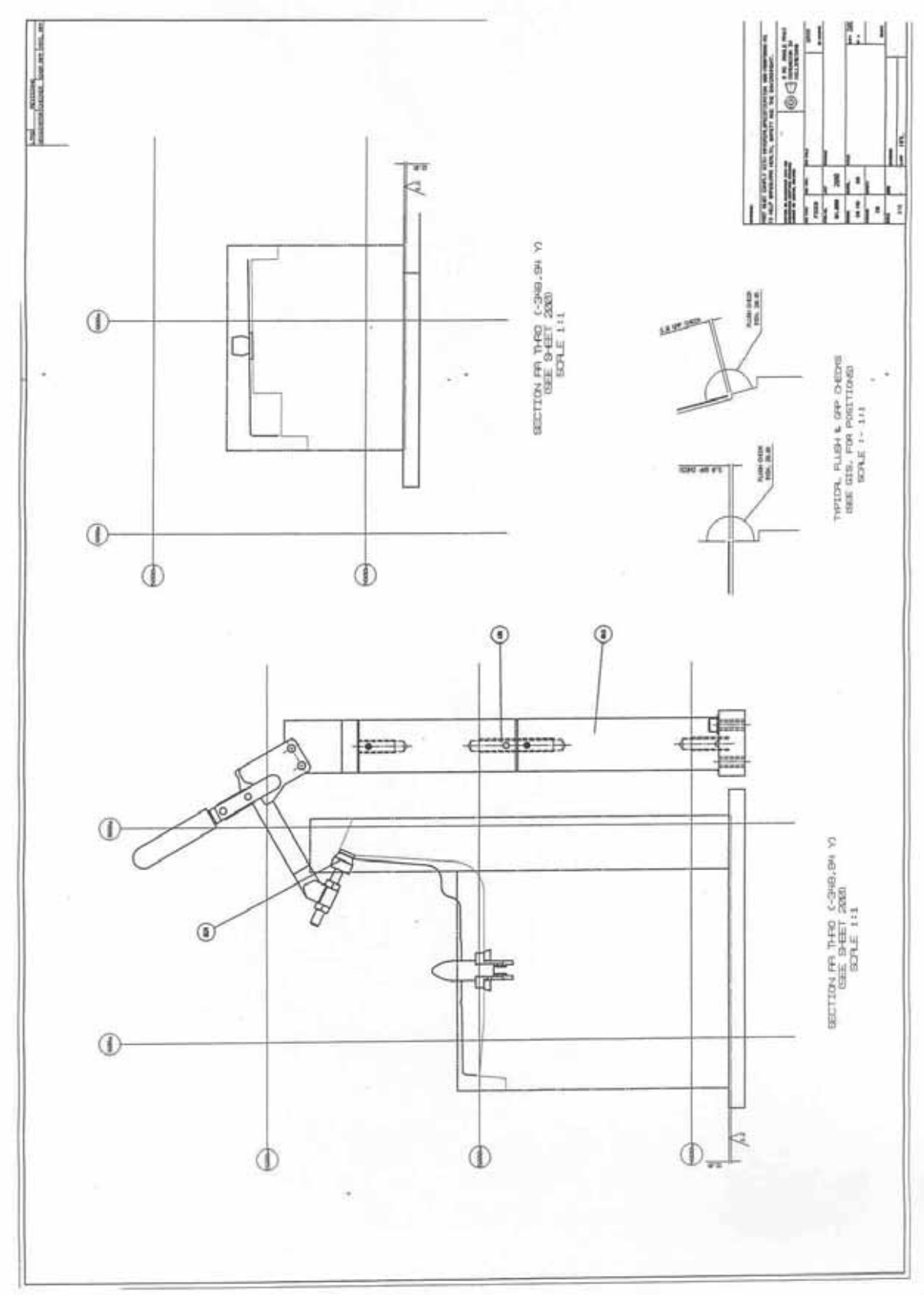
BODY CONSTRUCTION ENGINEERING — DESIGN STOCKLIST

CHG.	SHT.	ITEM	SUB	AMT LH	AMT RH	REFL	NAME	STOCKSIZES STANDARD NO. DRAWING NO. ORDER NO. (CRST. WEIGHT)	MATERIAL MANUFACT.	REMARKS
			002		1		PLATE	PCF/SP/FS/NH/100/A-		
								450		
		304		1	1	×	FORM & PLATE 4			
			001	1	1		BLOCK 2	BL 200×180×350	HARD	
									PLASTIC	
			002	1	1		BLOCK 1	BL 360×250×140	HARD	
									PLASTIC	
			003	1	1		PLATE 1	PCF/SP/FS/NH/200/A-		
								300		
			004	1	1		PLATE 2	PCF/SP/FS/NH/200/A-		
								300		
		305		1	1	×	FORM & PLATE 3			
			001	1	1		BLOCK 1	BL 280×215×240	HARD	
									PLASTIC	
			002	1	1		PLATE	PCF/SP/FS/NH/200/A-		
								300		
			003	1	1		BLOCK 2	BL 410×240×50	HARD	
									PLASTIC	

CHANGES	DESIGN	REMARKS/MYLAR/TITLE	DRAWING NO. LEFT	UNIT
CI00	DS MD			200
	DATE			SHEET
	CHECKED DS		DRAWING NO. RIGHT	101
DS PP8408	REVISION			SHEETS
				DP. NO. BH_000






SECTION AA THRO (-348.94 Y)
SEE SHEET 2001
SCALE 1:1
TYPICAL FLUSH & GAP CHECKS
SEE GIS. FOR POSITIONS
SCALE 1:1
SECTION AA THRO (-348.94 Y)
SEE SHEET 2001
SCALE 1:1