MANUAL

INSTRUMENT ENGINEERING PROCEDURES

DEP 32.31.00.10-Gen.

July 1985
(DEP Circulars 57/95 and 43/99 have been incorporated)

DESIGN AND ENGINEERING PRACTICE

USED BY

COMPANIES OF THE ROYAL DUTCH/SHELL GROUP

PREFACE

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They are based on the experience acquired during their involvement with the design, construction, operation and maintenance of processing units and facilities, and they are supplemented with the experience of Group Operating companies. Where appropriate they are based on, or reference is made to, national and international standards and codes of practice.

The objective is to set the recommended standard for good design and engineering practice applied by Group companies operating an oil refinery, gas handling installation, chemical plant, oil and gas production facility, or any other such facility, and thereby to achieve maximum technical and economic benefit from standardization.

The information set forth in these publications is provided to users for their consideration and decision to implement. This is of particular importance where DEPs may not cover every requirement or diversity of condition at each locality. The system of DEPs is expected to be sufficiently flexible to allow individual operating companies to adapt the information set forth in DEPs to their own environment and requirements.

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NOTE: In addition to DEP publications there are Standard Specifications and Draft DEPs for Development (DDDs). DDDs generally introduce new procedures or techniques that will probably need updating as further experience develops during their use. The above requirements for distribution and use of DEPs are also applicable to Standard Specifications and DDDs. Standard Specifications and DDDs will gradually be replaced by DEPs.

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1. INTRODUCTION

1.1 GENERAL

This manual describes project engineering procedures for the design, requisitioning, testing and inspection of instruments.

It replaces Section 5 of DEP 32.31.00.31-Gen., Instrument Engineering-General' dated July 1970. Some of the sections of this DEP are already covered by other publications and the remainder are being reconsidered in documents currently in hand, i.e. Sections 8, 9 and 11.

Consequently DEP 32.31.00.31-Gen., is being withdrawn at this time, since its contents no longer reflect current practices in those sections which are being revised. For any queries that arise on this subject the principal should be consulted.

The procedures are intended for use in oil refineries, chemical plants, gas plants and, where applicable, in exploration, production and new ventures.

Unless otherwise authorized by SIPM, the distribution of this manual is confined to companies belonging to or managed by the Royal Dutch/Shell Group, and to contractors nominated by them.

All publications referred to in this manual are listed in Section 10.

Where cross references are made, the number of the section or sub-section referred to is shown in brackets.

1.2 DEFINITIONS

For the purpose of this manual the following definitions shall hold:

Shall and **Should** - the word `shall' is to be understood as mandatory and the word `should' as strongly recommended to comply with the requirements of this manual.

The **Principal*** is the party which initiates the project and ultimately pays for its design and construction.
The Principal will generally specify the technical requirements. The Principal may also include an agent or consultant, authorized to act for the Principal.

The **Contractor** is the party which carries out all or part of the design, engineering, procurement, construction and commissioning for the project.
The Principal may sometimes undertake all or part of the duties of the Contractor.

The **Manufacturer/Supplier** is the party which manufactures or supplies equipment and services to perform the duties specified by the Contractor.

* For operating companies having a service agreement with SIPM or SICM the principal shall be taken as SIPM-MFEE/41.

2. GENERAL

2.1 INSTRUMENT ENGINEERING ACTIVITIES

In the context of this publication, instrument engineering comprises:

The engineering and design activities required for the supply and installation of the projected instrumentation and telecommunication facilities. This includes testing and inspection of instruments and systems at the suppliers workshop.

Unless otherwise specified, the Contractor's Instrument Engineer shall be responsible for carrying out the activities as mentioned hereafter. These activities comprise at least the following:

- Planning and scheduling the instrumentation work for the project within the overall project plan (3).
- The checking of process engineering flow schemes, utility engineering flow schemes, functional logic diagrams and flow charts (functional description).
- Preparing and updating instrument data sheets.
- The calculations for flow measuring instruments and control valves.

  NOTE: Flow sizing is normally done by the principal, based on computer input data sheets prepared by the contractor.
- The requisitioning of all instruments, accessories and installation materials (4, 5, 6).
- The assessment of quotations, selection of suppliers from the list of preferred manufacturers, checking copies of orders and suppliers data/drawings/documents.
- The factory inspection of panels, systems, etc. (7).
- Advising and assisting in the lay-out of instrument panels, operator consoles, control rooms, auxiliary instrument rooms, computer rooms and analyser houses.
- The design and engineering of alarm and trip systems.
- The design of analyser sample systems.
- The configuration of integrated control systems.

  NOTE: When stated in the project specification, the principal shall undertake this activity.
- The preparation of detailed documents and drawings for the ordering and installation of the instruments, etc. (8).
- The checking of plant models (9).
- Follow-up and progress control on all matters relating to instrument engineering.
- The design, engineering and requisitioning of telecommunication facilities.
- The preparation of `as-built' drawings.

The Contractor shall be responsible for all instrumentation and related activities, and for the satisfactory design and correct implementation of instruments and control systems in accordance with the principal's specifications.

For `split-phase' projects, responsibility shall be in accordance with the relevant section of the project specification.

2.2 DEMARCATIONS FOR INSTRUMENT ENGINEERING

Amended per Circular 57/95

Amended per Circular 43/99

For the interface between Instrument and Mechanical Engineering, refer to DEP 32.31.00.32-Gen. and DEP 31.37.00.11-Gen.

NOTE: The following items form part of mechanical engineering, for which the relevant engineering

information shall be supplied by instrument engineering, refer to DEP 32.31.00.32-Gen.:

- orifice flanges, orifice meter runs (made in accordance with Standard Drawing's)
- level gauge glasses, displacer chambers for level instruments
- thermowells
- safety/relief valves
- instrument air compressors, coolers, driers, buffer vessels and instrument air supply piping larger than DN 15, in accordance with the requirements of DEP 31.37.00.11-Gen.

2.3 DESIGN DATA FOR INSTRUMENT ENGINEERING

All instrument engineering shall be based on the design data given in Instrument data sheets and process and utility engineering flow schemes. Where necessary, additional information shall be provided to explain such plant operational requirements as:

- functional logic diagrams for (complicated) safeguarding systems
- flow charts (functional description) for sequence control systems
- functional diagrams for `advanced' control.

The Contractor shall continuously update the instrument data sheets and engineering flow schemes and submit these at defined intervals for the principal's approval.

In addition to the instrumentation listed during the detailed engineering phase, all other instrumentation, such as that for equipment packages, shall be included in the instrument data sheets and engineering flow schemes. Where this is not practicable, the additional instrumentation shall be shown on separate engineering flow schemes and instrument data sheets.

NOTES: 1) All process data shall be approved by the responsible process-control engineer before being used for instrument engineering.

2) The preliminary instrument data sheets as prepared in the basic or design phase, shall normally only show the process data. Hardware (engineering) data shall be stated in a later revision by the Contractor, see DEP 32.31.00.34-Gen.

2.4 THE BASIS FOR INSTRUMENT ENGINEERING

All instrument engineering work shall be based on the requirements given in the publications and amendments thereto, as listed in the Project Specification. In case of conflict between the publications referred to and the amendments and additional requirements, the latter shall be over ruling.

The contractor shall obtain the principal's written agreement for all deviations from the Project Specification, prior to carrying out the related engineering work.

Government and local authority requirements, laws and customs shall prevail if these are more stringent than those specified in the Project Specifications.

It is the contractor's responsibility that all the local legal obligations related to the scope of work and applicable to the realization of the project are complied with.

The contractor shall inform the principal immediately of any such local requirements which are not covered by the specifications indicated above.

Should doubt arise in the interpretation of rules given in the publications referred to above, the principal shall be consulted.

Compliance with the requirements of this specification shall not relieve the contractor of his obligation to follow sound and safe engineering practice throughout.

If changes in the design are considered necessary by the contractor for economic, safety, ease of operation, or other reasons they shall only be carried out after obtaining the principal's approval in writing.

2.5 INSTRUMENTATION OF EQUIPMENT PACKAGES

In general the instruments for equipment packages, such as boilers, incinerators, refrigeration equipment, compressors, etc., shall be of exactly the same make and type as those used for the process units. They shall be integrated with the requisition of the main process (control) instrumentation and shall be excluded from the responsibility of the equipment packages supplier.

Equipment package units shall therefore only be supplied with instruments which form an integral part of the equipment, all other instruments shall be supplied by the contractor, see DEP 32.31.09.31-Gen.

Where it is absolutely impossible to have the instrumentation excluded from the supply of the equipment packages, special care shall be taken that this is then entirely in accordance with the Project Specification. The Equipment Package supplier shall be informed of the selected types and manufacturer's of the preferred instruments, in order that the instrument installation, including all materials, shall be in accordance with the overall requirements for the total project. This requirement shall then be clearly stated on the requisition for the unit, and the equipment package supplier shall be provided with all pertinent documents and drawings.

The principal's approval shall be obtained in writing for all such deviations.

3. TIME SCHEDULE

All phases of instrument engineering work shall be planned in detail and in accordance with the overall time schedule for the project. Special attention shall be given to the timing of the following:

- The preparation of:
  - `the summary of instrumentation documents and drawings'
  - `the summary of instrumentation requisitions

  These summaries shall indicate all expected engineering documents, drawings and requisitions together with the expected date of issue. They shall be issued within 2 months after the award of the contract and be updated and re-issued at 2 monthly intervals.

  The documents will then be used as the basis for the detailed instrument engineering planning.
- ROS (Required on site) date, for equipment.
- ROS (Required on site) date, for documents and drawings, etc.
- The finalization of computer input sheets for flow calculations. This data shall be available at least 6 months before the planned date of plant commissioning.
- Plant Model Checks.

4. REQUISITIONING

4.1 GENERAL

The requisitioning of all instruments, instrument systems, auxiliary equipment, installation materials etc. shall be based on the relevant (process) data and on the makes and types specified by the principal for the particular project, in the `List of selected instrument equipment', which is Standard Form DEP 05.00.54.40-Gen.

All requisitions which are not in `computerized' format shall be provided with a cover sheet, the so-called EDP supplement (Electronic Data Processing), which is Requisitioning Sheet DEP 40.00.10.93-Gen.

The required make and type of instrument etc. shall be stated on the EDP supplement to the requisition, numbering all items and giving the quantity per item.

When equipment or materials are free issue items to other suppliers, the contractor shall provide a clear description and all applicable cross references.

The contractor shall prepare separate requisitions for `in line' instruments which have a pressure rating of ANS 1500 class and higher, they shall be segregated from requisitions which contain instruments of a lower pressure rating.

NOTE: `In line' instruments, include all instruments and components mounted in process lines or equipment. Typical examples are control valves, safety valves, displacer level instruments, orifices plates/restriction orifices, turbine meters and positive displacement meters, etc.

4.2 REQUISITIONING PROCEDURES

Requisitions shall be prepared for the purchase of all instruments shown in the Engineering Flow Schemes and listed in the instrument data sheets, including all auxiliary equipment and installation materials. These requisitions shall clearly state all the requirements and data necessary for the supply of correct materials.

NOTE: The requisitions are intended as a starting point for the purchasing procedures and may only indicate preliminary information as derived from the Instrument Data Sheets. If more details are required at a later stage they shall be taken from the documents supplied by the Manufacturer.

Requisitioning procedures shall be based on DEP 30.10.01.10-Gen. `Requisitioning' and DEP 40.10.01.11-Gen. `Coding system for the administration and control of capital projects'.

Requisition sheets for specific instruments not included in DEP 30.10.01.10-Gen., shall be prepared by the contractor using `general purpose' requisition sheets. When these sheets are used, the DEP number, i.e. 31.10.00.93-Gen., shall be removed.

NOTE: Examples of instrument requisition sheets not included in DEP 30.10.01.10-Gen., may be supplied by the principal.

The types of material specified on any one requisition should `preferably' be limited to those which can all be supplied by the same manufacturer.

To minimize paper flow and to assist in efficient purchasing and expediting procedures, the total number of requisitions issued, and the number of items per requisition shall be kept to a minimum.

This may be achieved by, but not be confined to the following:

- Including the instrumentation for several units in a `combined' project, on one requisition.

  NOTE: This is only allowed if a special `project number' has been reserved for the ordering of instruments and associated materials. Moreover, it requires the availability of all process data for all units (and utilities) at an early stage of the project.

- Combining identical instruments, etc., under one item number.

Typical items which allow this procedure are:

1) Orifice plates. - Individual item numbers shall be assigned for each combination of type, size, bore and material required. All tag numbers (and any other necessary information for requisitioning) shall be collected under each relevant item number.

2) Pressure gauges, receiving gauges, differential pressure transmitters. - As 1) above

but arranged according to type and meter range.

The system of sub-groups given in DEP 40.10.01.11-Gen., shall however prevail. It is therefore not allowed to combine for example, transmittersfor flow, level and (differential) pressure on one requisition, although the instruments required could be identical.

3) Nameplates. - As 1) above but arranged according to size and colour (engravings may differ).

On-line process stream analysers shall be specified by tag number on individual requisitions, with separate indent numbers to facilitate reference in correspondence, identification at site, in instruction manuals and of sampling system components, etc.

Telecommunication equipment should be specified for each system, e.g. CCTV, Plant radio, etc., on individual requisitions with separate indent number and itemized for each combination of type.

4.3. INFORMATION IN REQUISITIONS

The requisitions shall only carry the information necessary for ensuring the proper supply of the equipment and/or services required.

When required, in addition to the operating conditions specified on the requisition, the contractor shall also state requirements such as vacuum service, high pressure, low and high temperature, oxygen service, strongly varying process conditions, corrosive and abrasive conditions.

Furthermore, the specific requirements given in the Project Specification shall be stated on the requisitions and special attention shall be given to the following:

- Material certification of instruments and related components for pressure retaining parts, including the bolting of pressure retaining parts.
- Special testing and/or treatment of materials, e.g. leak, dye penetration, ultrasonic, magnetic particle, hardness, heat treatment, stress relieving, annealing/pickling, etc., shall be in accordance with the requirements given for the piping system or equipment in which the instruments are to be installed, and/or the Project Specification.

  NOTE: Pressure testing is mandatory for all pressure retaining instruments and/or installation materials.
- For welded parts, the percentage of X-ray.
- Requirements for the maximum allowable noise level, e.g. for control valves, control room equipment, etc.
- The `NACE Requirements' for `in line' instruments used in sour service.

The contractor shall carefully check the supplier's information to ensure the correct supply of equipment and/or services.

Complete tag numbers shall be stated on the requisition for identifying instruments and accessories during installation. This is not necessary for installation materials which are identified, stored and used by indent/item numbers.

4.4 COMMENT/APPROVAL BY PRINCIPAL

When the contractor is requested by the principal to submit all requisitions for comments and/or approval, the relevant up-to-date instrument data sheets and other relevant documents e.g. control valve calculation sheets shall be issued prior to, or simultaneously with the requisition.

Quotations for approval shall be submitted with all relevant documents included, such as catalogues, intermediate correspondence and drawings, etc.

4.5 ENGINEERING SPARES

The requisitions, especially initial requisitions, should include an amount of certain extra

equipment as `engineering spares' to allow for losses of installation materials, or for late changes at site.

The contractor shall propose for each of the (initial) requisitions an amount of engineering spares. The amount of these spares requires the written approval of the principal.

4.6 FREE ISSUE ITEMS

If the requisition for the main equipment contains free issue items, cross references shall be made between the requisitions for main equipment and free issue items, giving the requisition number, make and type of instrument/equipment and quantities.

4.7 PRELIMINARY REQUISITIONS

To ensure timely delivery, preliminary requisitions shall be issued for certain equipment at an early stage of the detailed engineering, to allow the manufacturer to reserve manufacturing capacity and to order sub-assemblies and parts.

Such equipment may be:

- control valves with components made from non-standard/ special materials or integrated control systems, etc.
- panel instruments and flow transmitters when required in large quantities (with estimated quantities).

They shall be followed by updated revised requisitions at a later stage.

Initial requisitions for installation materials and cables should be issued with estimated quantities and average lengths of cable required for each instrument. The requisitions shall be revised and re-issued at a later date when final quantities and lengths are known, together with an approved amount of engineering spare materials and cable.

4.8 FACTORY INSPECTION

Requisitions for equipment of `Category B' and `Category C', see (7), shall carry a note that the equipment will be inspected after factory-testing and before shipment.

4.9 ERECTION/COMMISSIONING ASSISTANCE

Requisitions for factory assembled systems and items of equipment in `Category B', Appendix 1 refers, shall specify whether erection and/or commissioning assistance and/or a 6 months or 1 year maintenance contract is required from the supplier, or as otherwise stated in the Project Specification.

4.10 REVISIONS

Revisions to requisitions shall only be issued if they have a significant influence on the material to be supplied, for example, marginal changes in operating conditions should not be the cause for revised requisitions. The Instrument Data Sheets shall, however, always be very carefully updated.

Revision indicators shall be placed close to the changed information, or at the end of the line, but **always** inside the frame of the requisition.

Revised requisitions shall be issued as **complete** documents including any unchanged sheets.

Reasons for a revision include:

- a change in quantity of specified items
- the addition or deletion of items
- a change of instrument tag numbers.

It is **not** allowed in revisions to:

- change item numbers
- re-use an item number which has previously been cancelled.

Before issuing revised requisitions at a late stage of the engineering phase, the procurement status of the existing requisition shall be checked to determine the best solution for meeting the new requirements.

5. SPARE PARTS FOR INSTRUMENTS

For procedures see DEP 70.10.90.11-Gen.

The Spare Parts Interchangeability Records (SPIR) detailed therein, shall be prepared for each project, even if the ordering of spare parts is not expected.

6. COMPOSITE MANUALS

The contractor shall ensure that manufacturers/suppliers are instructed to supply to site, either by direct dispatch or via the contractor's office in accordance with the Project Specification, complete sets of all instrument installation, commissioning and maintenance manuals, applicable to each type of equipment in their supply. Where practicable, these sets shall be assembled in loose-leaf binders.

For the larger systems, provided by the same supplier, the sets shall include all details of all the types of instruments supplied, e.g. for integrated control system, blender, metering station, etc.

7. FACTORY INSPECTION

7.1 DECISION FOR INSPECTION

To facilitate the requirements for factory inspection, the instrumentation shall be separated into `Category A', `Category B' or `Category C' Items as appropriate, see Appendix 1.

Equipment in Category A will not normally require a factory inspection, but all equipment in Category B **shall** be subjected to factory inspection and equipment in Category C **should** be inspected before dispatch.

NOTE: The need for inspection of items in Category C shall be indicated by inserting the letter `I' - in the code column of the list of selected instrument equipment, Standard Forms - DEP 05.00.54.40-Gen.

Material in Category A, which forms an integral part of the equipment of Category B, will be inspected against the relevant requirements during the inspection of Category B material , e.g. controllers and recorders in a control desk will be checked against the requisition in the panel shop, during the acceptance test of the control desk.

The requirements for factory inspection shall be clearly indicated in the requisition for the particular equipment.

Factory inspection shall be carried out by:

- the Principal; for non turnkey projects
- the Contractor; for turnkey projects, either alone or (at the principal's discretion) accompanied by a representative of the principal.

The contractor shall ensure for turnkey projects whether the principal intends to witness such tests. For split-phase projects, testing shall be carried out, or witnessed by the principal.

7.2 INSPECTION

Prior to factory inspection by or on behalf of the principal, the manufacturer shall carry out tests and if necessary take corrective measures, with the approval of the principal, in order to ensure that all equipment fulfils the requirements stated in the requisition. This shall include equipment which is supplied with equipment packages or as free issue items.

The factory inspection, by or on behalf of the principal, shall include full loop and function tests for which floor space, simulation equipment and manpower assistance shall be provided by manufacturer.

The inspection date shall be fixed at least two weeks in advance.

One set of approved, up-to-date vendors drawings, including test procedures, shall be supplied to the principal, before the inspection is carried out.

NOTE: If, for any reason the purchaser waves inspection, it shall not relieve the supplier from repairing at his cost any defects found later.

7.3 QUALITY ASSURANCE REQUIREMENTS

For turnkey projects, the contractor shall establish, document and maintain, an effective quality assurance system to demonstrate compliance with the requirements for services and manufactured products, in accordance with the relevant section of the Project Specification.

8. DOCUMENTS AND DRAWINGS

For guidance as to which instrument documents and drawings should be made in the engineering stage, refer to DEP 32.31.00.34-Gen.

The engineering documents and drawings shall be processed and submitted to the principal in a logical sequence for comments, or released in accordance with the requirements of the Project Specification, to ensure proper coordination of responsibilities and activities.

If available, the contractor may use his own computerized system for handling documents and drawings, having first obtained the principal's approval in writing.

9. PLANT MODELS

If a plant model forms part of the specification, construction of the model shall comply with DEP 30.10.05.11-Gen.

In the event of a model check, special attention shall be given to:

- correct location of control rooms/analyser houses
- location and access of main cable routes/junction boxes
- straight piping lengths for flow meters
- accessibility of instruments
- free clearance for insertion or withdrawal of certain instruments e.g. displacers, capacitive level probes, temperature elements, etc.
- location of closed circuit television cameras, see also Appendix B of DEP 32.71.00.10-Gen.

10. REFERENCES

In this specification reference is made to the following publications.

NOTE: The latest issue of each publication shall be used together with any amendments/supplements/revisions to such publication.

It is particularly important that the effect of revisions to international, national or other standards shall be considered when they are used in conjunction with DEPs, unless the standard referred to has been prescribed by date.

Standard Form `List of selected instrument equipment'	DEP 05.00.54.40-Gen.
Requisitioning	DEP 30.10.01.10-Gen.
Model construction for processing units	DEP 30.10.05.11-Gen.
Instrument air supply	DEP 31.37.00.11-Gen.

Amended per Circular 57/95

Amended per Circular 43/99

Instruments for measurement and control	DEP 32.31.00.32-Gen.
Instrumentation documents and drawings	DEP 32.31.00.34-Gen.
Instrumentation for equipment packages	DEP 32.31.09.31-Gen.
Plant telecommunication	DEP 32.71.00.10-Gen.
Coding system for the administration and control of capital projects	DEP 40.10.01.11-Gen.
Spare parts for initial and normal operation	DEP 70.10.90.11-Gen.

AMERICAN STANDARD

Sulfide stress cracking resistant metallic material for oil field equipment	NACE Standard MR-10-75 (1980 Revision)

Issued by:
National Association of Corrosion Engineers
1440, South Creek, Houston,
Texas 77084, USA

11. APPENDICES

Inspection requirements, Equipment categories - Appendix 1.

APPENDIX 1 INSPECTION REQUIREMENTS

EQUIPMENT CATEGORIES

Category A - comprising individual items of equipment and separately mounted instruments.

Typical items in this category are:

- transmitters
- recorders
- controllers (including indicating controllers)
- pressure/draught/receiving/temperature gauges
- installation materials (except for impulse lines containing valves)
- solenoid valves
- plant mounted terminal/junction boxes
- switches (manual/receiver and process)
- push buttons
- cables (except system cables)
- variable-area meters (except for process applications)
- indicators (including receiving indicators)
- diaphragm seals
- manual loading stations
- howlers
- integrators
- pulse counters
- alarm light units
- computing/selecting/limiting/boosting/time relays
- air filter-reducers
- TC assemblies
- resistance thermometer elements/RTD's
- detectors
- tank gauges
- signal converters
- volume boosters
- load cells
- lock-up/quick exhaust devices
- control drives for dampers
- valve actuators/positioners.

Category B - comprising instruments and equipment of a more complex nature, custom-built systems or equipment packages.

Typical items of equipment in this category are:

B.1 - Field equipment such as:

- local panels
- metering station
- meter provers.

B.2 - Analytical equipment such as:

- sampling systems for process stream analysers
- process stream analysers.

B.3 - Piped and wired system cabinets or racks for:

- receiver switches
- signal converters
- signal amplifiers
- miscellaneous/auxiliary components.

B.4 - Control room equipment such as:

- control desks
- alarm systems/alarm service units

- safeguarding systems
- interlock systems
- sequential control systems
- relay systems
- binary logic systems (all types)
- tank gauging systems
- interposing cabinets
- monitoring systems
- fire and smoke detection systems
- distribution frames or cabinets
- weighing systems
- dosing systems
- blending systems
- sequential event recorder
- printers
- gas detection systems
- multi point temperature systems (only for 100 points and complex systems)
- batch control units or counters
- integrated control systems
- multiplexers
- operator consoles
- graphic panels
- prefabricated (system) cables
- interface systems
- computer systems.

B.5 - Plant telecommunication equipment such as:

- closed circuit television (CCTV)
- telemetering systems
- telecommunication systems (for complex systems only).

NOTES: 1) If the contractor considers it to be necessary, or when required by the principal and stated in the project specification, the more complicated instruments and equipment shall be commissioned by the manufacturer

2) If doubt should arise regarding erection/commissioning assistance from the supplier, the principal shall be consulted.

Category C - comprising in-line mounted instruments and items for instrument impulse lines

Typical items of equipment in this category are:

C.1 - In line mounted instruments such as:

- orifice plates/restriction orifices
- variable area meters
- special meter runs. (e.g. for custody transfer)
- turbine/PD meters (including all accessories)
- venturi/dall/pitot tubes
- electromagnetic/vortex/impact/ultrasonic flow meters
- flow straighteners
- flow nozzles
- displacer level instruments
- probe-type level instruments control valves/safety valves
- pressure/self acting temperature regulators

C.2 - Installation materials (for impulse lines) such as:

- gauge blocks
- manifold blocks

NOTE: All instruments and installation materials in Category C which are to be inspected, shall be examined by a mechanical specialist to ensure compliance with the piping specification.