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ESO MECHANICAL STANDARDS

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Contents

1	SCOPE	6
2	RELATED DOCUMENTS	7
2.1	Applicable Documents	7
2.2	Reference Documents	8
3	INTRODUCTION	9
4	GENERAL REQUIREMENTS	10
4.1	Standards	10
4.2	Safety	10
4.2.1	Design Classification	10
4.3	Units	11
4.4	Coordinate systems	12
4.5	Threads	12
4.6	Technical Drawings	12
4.6.1	General	12
4.6.2	Language	12
4.6.3	Drawing Sheets	12
4.6.4	Scale	13
4.6.5	Piping and Instrumentation Drawings	13
5	MATERIALS CONTROL	14
5.1	Selection of Materials	14
5.2	Technical criteria for the selection of materials	14
5.2.1	General	14
5.2.2	Thermal Treatment	14
5.2.3	Surface Treatment	15
5.2.4	Corrosion	15
5.2.5	Stress-corrosion	15
5.2.6	Vacuum	16
5.2.7	Reaction to Fire	16
5.2.8	Service Life	16
5.2.9	Hazardous Materials	16
5.2.10	Prohibited Materials	16
5.2.11	Galvanic compatibility	16
5.3	Materials Traceability	17
5.4	Part Identification	17
6	ESO STANDARD PARTS	18
6.1.1	Nuts	18
6.1.2	Screws	19
6.1.3	Washers	20
6.1.4	Pins	20
6.1.5	O-Rings	21
6.1.6	Retaining Rings	21
6.1.7	Gears	21
6.1.8	Bearings	21
6.1.9	Keys	21
6.1.10	Couplings	22
6.2	Selection of Parts that are not ESO Standard	22



7	SPECIFIC ESO DESIGN REQUIREMENTS	23
7.1	Structural Design	23
7.2	Bolted Joints	23
7.3	Piping Systems	24
7.3.1	Definition of Nominal Sizes.....	24
7.3.2	Labelling.....	24
7.3.3	Calibration of Measuring Devices.....	25
7.3.4	Pipe Hangers and Supports.....	25
7.4	Hydraulic Oil Systems	25
7.4.1	General Requirements.....	25
7.4.2	Pipe and Tubing Materials	25
7.4.3	Connections	26
7.4.4	Fittings	26
7.5	Pneumatic Systems	27
7.5.1	General Requirements.....	27
7.5.2	Threads.....	27
7.5.3	Tubing	27
7.5.4	Fittings	28
7.6	Nameplates and Product Marking	29
7.7	Consumables.....	29
7.7.1	Lubricants	29



Abbreviations and Acronyms

AD	Applicable Document
CIDL	Configuration Item Data List
CETOP	CETOP (C omité E uropéenne des T ransmissions O léo hydrauliques et P neumatiques). CETOP is the European Fluid Power Committee.
COTS	Commercial Off The Shelf (products)
CRE	Change Request
DIN	Deutsches Institut für Normung
EC	European Community
EN	European Standard
EELT, E-ELT	European Extremely Large Telescope
ELT	Extremely Large Telescope
ESO	European Organization for Astronomical Research in the Southern Hemisphere
HVAC	Heating, Ventilation and Air Conditioning
ISO	International Standards Organisation
SCP	Service Connection Point
VDI	Verein Deutscher Ingenieure
VLT	Very Large Telescope



1 Scope

This document defines the Mechanical Standards applicable to the design and manufacturing of products operated at ESO observatories.

For mechanical systems already installed in Paranal and La Silla, it is to be used as a guideline for replacement of components. It is not intended that existing mechanical systems retroactively comply with this standard.

This document is intended to enable Engineers to produce mechanical designs to a standard considered acceptable by ESO. It is still the responsibility of the Project Manager to ensure that all necessary requirements are met

It is also intended to ease the integration, operation and maintenance of the different instruments and telescopes.

This document is not intended to contain all the standards necessary to produce all types of mechanical design and should therefore be supplemented by additional supporting documentation where and when necessary.



2 Related Documents

2.1 Applicable Documents

The following documents, of the exact issue shown, form part of this standard to the extent specified herein. In the event of conflict between the documents referenced herein and the content of this document, the content of this document shall be considered as a superseding requirement.

- AD1 BS 5380 Specification for hydraulic port and stud coupling using 'O'-ring sealing and 'G' series fastening threads
- AD2 BS 5409-1 Specification for nylon tubing. Fully plasticized nylon tubing types 11 and 12 for use primarily in pneumatic installations
- AD3 BS 5409-2 Specification for nylon tubing. Plasticized and Unplasticised nylon tubing types 11 and 12 for use primarily in the automobile industry
- AD4 DIN 837-1 Pressure gauges - Part 1: Bourdon tube pressure gauges; dimensions, metrology, requirements and testing
- AD5 DIN 3852-1 Stud ends, ports, for fittings, valves - Part 1: Plug screw with metric fine pitch thread; General outlay of types
- AD6 DIN 73378 Polyamide tubing for motor vehicles
- AD7 DIN 74324 Air braking systems - Thermoplastic tubing - Part 1: Requirements and tests
- AD8 EN Eurocode 0 - Basis of Structural Design
- AD9 EN Eurocode 3 Steel – Design of Steel Structures – All parts
- AD10 EN Eurocode 4 Design of Composite Steel and Concrete Structures – All parts
- AD11 EN Eurocode 9 Design of Aluminium Structures – All parts
- AD12 ISO 7-1 Pipe threads where pressure-tight joints are made on the threads -- Part 1: Dimensions, tolerances and designation
- AD13 ISO 228-1 Pipe threads where pressure-tight joints are not made on the threads -- Part 1: Dimensions, tolerances and designation
- AD14 ISO 261 ISO general purpose metric screw threads -- General plan
- AD15 ISO 262 ISO general purpose metric screw threads -- Selected sizes for screws, bolts and nuts
- AD16 ISO 965-1 ISO general-purpose metric screw threads -- Tolerances -- Part 1: Principles and basic data
- AD17 ISO 1127 Stainless steel tubes -- Dimensions, tolerances and conventional masses per unit length
- AD18 ISO 1219-1 Fluid power systems and components -- Graphic symbols and circuit diagrams -- Part 1: Graphic symbols for conventional use and data-processing applications
- AD19 ISO 3601-1 Fluid power systems -- O-rings -- Part 1: Inside diameters, cross-sections, tolerances and designation codes
- AD20 ISO 4200 Plain end steel tubes, welded and seamless -- General tables of dimensions and masses per unit length



- AD21 ISO 4413 Hydraulic fluid power -- General rules and safety requirements for systems and their components
- AD22 ISO 4414 Pneumatic fluid power -- General rules and safety requirements for systems and their components
- AD23 ISO 5455 Technical drawings – Scales
- AD24 ISO 5457 Technical product documentation -- Sizes and layout of drawing sheets
- AD25 ISO 5599-2 Pneumatic fluid power -- Five-port directional control valves -- Part 2: Mounting interface surfaces with optional electrical connector
- AD26 ISO 6412-1 Technical drawings -- Simplified representation of pipelines -- Part 1: General rules and orthogonal representation
- AD27 ISO 6708 Pipework components -- Definition and selection of DN (nominal size)
- AD28 ISO 7005-1 Pipe flanges -- Part 1: Steel flanges for industrial and general service piping system
- AD29 ISO 7241-1 Hydraulic fluid power -- Quick-action couplings -- Part 1: Dimensions and requirements
- AD30 ISO 10628 Flow diagrams for process plants -- General rules
- AD31 ISO 15171-2 Connections for fluid power and general use -- Hydraulic couplings for diagnostic purposes -- Part 2: Coupling with M16 x 2 end for connection under pressure
- AD32 ISO 15407-1 Pneumatic fluid power -- Five-port directional control valves, sizes 18 mm and 26 mm -- Part 1: Mounting interface surfaces without electrical connector
- AD33 ISO 15407-1 Pneumatic fluid power -- Five-port directional control valves, sizes 18 mm and 26 mm -- Part 2: Mounting interface surfaces with optional electrical connector
- AD34 ISO 16028 Hydraulic fluid power -- Flush-face type, quick-action couplings for use at pressures of 20 MPa (200 bar) to 31,5 MPa (315 bar) -- Specifications
- AD35 ISO 23605 Technical product specification (TPS) -- Application guidance -- International model for national implementation
- AD36 ISO 80000-1 Quantities and units – Part 1 : General

2.2 Reference Documents

The following reference documents provide background information as to the present Specification. Under no circumstance shall the content of reference documents be construed as applicable to the present standard, in part or in full.

- RD1 SAF-INS-ESO-00000-3444 Last Issue Safety Conformity Assessment Procedure
- RD2 Directive 2006/42/EC of the European Parliament and of the Council of 17 May 2006 on Machinery, and amending Directive 95/16/EC (recast)
- RD3 VDI 2230 Systematic calculation of high duty bolted joints - Joints with one cylindrical bolt
- RD4 <http://www.hydrotechnik.com/english/html/minimess.html>



3 Introduction

Due to the nature and location of the observatories that ESO operates it is essential that certain standards are adopted and applied. As previously mentioned, this document details the major mechanical standards which ESO deems necessary to produce, and later on maintain, complex mechanical items.

The document is split into various sections for easy reference. It begins with general requirements related to the application of international standards, engineering drawings, definition of general coordinate systems, general definition of threads, and a brief statement of how safety requirements shall be applied to mechanical designs which are produced for ESO.

The next section details the requirements related to the selection of materials for mechanical components

Next is the section that focuses on the definition of standard components such as screws, nuts, washers, etc. In order to achieve a degree of standardisation across the observatories.

Finally, the last section is concerned with ESO specific requirements for mechanical design and covers such issues as structural design, bolted joints, and both hydraulic and pneumatic piping systems.

It is important to note that certain aspects are not covered by this document, for instance detailed safety requirements, document management requirements, CAD formats, etc..



4 General requirements

4.1 Standards

For all standard parts and mechanical components the International and National Standards shall be applied where directly applicable.

The following hierarchy of Standards shall be applied:

1. Standard defined directly by ESO contractual documents
2. EN standards
3. ISO standards
4. DIN, BS, or other equivalent national standards
5. Design guidelines from professional organizations (VDE, VDI Richtlinien, F.E.M., etc).

4.2 Safety

The safety requirements and safety conformity demonstration applicable to machinery and instruments developed and produced by ESO internally and/or by external contractors is as defined in RD1, but the additional rules in the following shall be adhered to.

4.2.1 Design Classification

The recipient of this standard is responsible for determining, declaring, and demonstrating the relevant classification to which their design applies.

Dependent on this classification, relevant standards and safety requirements must be met in order to produce an adequate design.

In this context three classifications to which a mechanical design can belong to shall be considered.

4.2.1.1 Machinery

According to RD2, 'machinery' is defined as:

- *an assembly, fitted with or intended to be fitted with a drive system other than directly applied human or animal effort, consisting of linked parts or components, at least one of which moves, and which are joined together for a specific application,*
- *an assembly referred to in the first indent, missing only the components to connect it on site or to sources of energy and motion,*
- *an assembly referred to in the first and second indents, ready to be installed and able to function as it stands only if mounted on a means of transport, or installed in a building or a structure,*



- *assemblies of machinery referred to in the first, second and third indents or partly completed machinery referred to in point (g) which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole,*
- *an assembly of linked parts or components, at least one of which moves and which are joined together, intended for lifting loads and whose only power source is directly applied human effort*

The safety of designs falling into this category will be dealt with via the Machinery Directive (See RD2).

4.2.1.2 Structures

A structure is a body or assemblage of bodies in space to form a system capable of supporting loads. The effects of loads on physical structures are determined through structural analysis.

Built structures are composed of structural elements such as columns, beams and trusses. Built structures are broadly divided by their varying design approaches and standards, into categories including Building structures, Architectural structures, Civil engineering structures and Mechanical structures.

The design rules and verifications detailed in AD9 shall be applied for frames or similar non-moving structures with predominantly static loading carrying loads which could in the case of failure endanger persons or valuable installations.

Load lifting accessories and handling equipment used in labs and observatories, temporarily or permanently, shall be subject to the Machinery directive (See RD2).

Additionally for moving structures (e.g. the telescope main structure, dome, etc.) the design and safety rules for machinery and cranes shall be applied accordingly. They cannot be treated as purely a building because unlike buildings they are subject to dynamic loading.

4.2.1.3 General Mechanical Design

General engineering rules chosen by the design engineer shall be applied for general mechanical elements which meet all of the following criteria:

- In the case of failure do not lead to hazards for people or equipment.
- Where the failure can be detected easily by the professional users.
- Are only accessible to qualified personnel.

Unless otherwise specified, the term failure (of a function or item) refers to the situation where applicable requirements (functional or performance requirements) are no longer met. A failure may lead to downtime of the associated item or function, or to be degraded but still operable condition. The term critical failure is reserved for more severe, no longer operable conditions.

4.3 Units

For the design and construction of all ESO products, SI units as according to AD36 shall be exclusively used. If other alternative units are provided additionally in any document, the corresponding SI units must be provided as well.



4.4 Coordinate systems

Projects shall define unequivocal coordinates systems.

Coordinates systems shall follow the right-hand rule. Where this is not possible (e.g. coordinates systems after optical propagation), explicit warning shall be given and transformation matrices provided.

4.5 Threads

Threads shall be selected according to AD15

Where it is not appropriate to use threads according to AD16, for example due to space restrictions, performance requirements, etc., threads according to ISO 261 are permitted to be used but justification must be submitted to the project.

AD16 applies for thread designation. This norm specifies the basic profile for ISO general purpose metric screw threads (M) conforming to AD13.

For threads for the specific applications of Hydraulic Oil systems, Chilled Medium Distribution systems, and Pneumatic Air systems please refer to the relevant sections within this document.

4.6 Technical Drawings

4.6.1 General

As a general rule, technical drawings shall be in created in accordance with AD35.

4.6.2 Language

Drawings shall be in English or with an English translation.

4.6.3 Drawing Sheets

Standard drawing paper sizes shall follow AD24, series A, from A0 to A4. The sheet size A5 shall not be used.



4.6.4 Scale

According to AD23 the recommended scaling factors to be used within technical drawings are:

Magnification	50:1	20:1	10:1
	5:1	2:1	
Natural scale	1:1		
Reduction	1:2	1:5	1:10
	1:20	1:50	1:100
	1:200	1:500	1:1000
	1:2000	1:5000	1:10000

Table 1 - Scale Factors according to ISO 5455

4.6.5 Piping and Instrumentation Drawings

Piping and instrumentation drawings/diagrams (P&ID) shall be in accordance with AD30.

Simplified piping presentation shall be in accordance with AD26

Symbols shall be in accordance with AD18. This norm establishes basic elements for symbols. It lays down rules for devising fluid power symbols for use on components and in circuit diagrams



5 Materials Control

5.1 Selection of Materials

Materials shall be chosen giving preference to the following:

1. Those successfully used for an identical application with respect to environment constraints and lifetime of the proposed application.
2. Those for which satisfactory evaluation results are obtained on samples representative of the application with a sufficient margin as regards conditions of use.

Whether the materials are already validated or remain to be validated, their selection shall take into account the following criteria:

1. Continuity of supply over the specified lifetime of the project.
2. Reproducibility of characteristics.

5.2 Technical criteria for the selection of materials

5.2.1 General

Materials shall be selected in accordance with international and national Standards as far as possible.

Materials shall be selected in accordance with the manufacturer's recommendations.

The material for each custom made part shall be indicated in the drawing or in the parts list according to ISO or EN recognised designations.

Material properties shall be compatible with the environment to which they are exposed. This is not necessarily only the final environment but includes the localised environment during shipping, storage, etc..

5.2.2 Thermal Treatment

Thermal treatments shall be specified in the part drawings.



5.2.3 Surface Treatment

The selection of a surface treatment shall be fully justified in the design report and this justification shall include the following:-

- Any applicable surface preparation (including any necessary cleaning procedures)
- Type of treatment to be applied
- Thickness of the applied treatment
- Number of layers to be applied (where applicable)
- Define the expected lifetime of the treatment
- Instructions for planned maintenance (where applicable)
- Instructions for repair, e.g. touch-up on site (where applicable)
- Conformance with the local environment in which the treated component will be situated.

When protective coatings are specified for the purposes of transportation and storage, a clear procedure on the removal of said coating before use shall be given.

For each item the proper process for surface treatment shall be defined and documented.

The surface treatment shall respect the environmental conditions during operation, maintenance, transport and storage.

When a component is situated close to an optical path then the reflectivity/emissivity of the surface treatment shall be assessed with regard to project requirements.

Hazardous materials or processes shall be avoided whenever possible (See also section 5.2.9) but when completely unavoidable the legal requirements of the source country as well as the host country (of the component) shall be considered.

5.2.4 Corrosion

For all materials it shall be demonstrated that the degradation of properties during their anticipated service-life is acceptable in terms of the performance and integrity requirements in terms of all applicable requirements.

In addition, corrosion of materials shall not degrade the performance of any system through contamination, for example rust falling onto a mirror surface.

Corrosion-susceptible materials shall be sufficiently protected in order to comply with the lifetime requirement and within the applicable environmental conditions

5.2.5 Stress-corrosion

Materials used for structural and load-bearing applications shall be chosen so that they are not susceptible to stress corrosion cracking (SCC), i.e. if a susceptible material is placed in service in a corrosive environment under tension of sufficient magnitude, and the duration of service is sufficient to permit the initiation and growth of cracks, a failure occurs at a stress lower than that which the material is normally be expected to withstand. The corrosive environment need not be severe in terms of general corrosive attack.



5.2.6 Vacuum

Great care has to be paid to the nature of the material entering inside a vacuum chamber (especially for parts remaining at room temperature).

5.2.7 Reaction to Fire

Materials shall be selected in a view to limit their reaction and contribution to fire. Any fire related risks shall be identified in the Hazard Analysis and any subsequent hazards mitigated.

5.2.8 Service Life

Materials shall be selected to ensure sufficient life with respect to the intended application.

Limited life materials shall be identified and declared. In particular, any material with lifetime less than the specified lifetime of the host equipment shall be identified, its replacement/refurbishment shall be possible over the specified lifetime, and included in the maintenance plan of the host equipment.

5.2.9 Hazardous Materials

As a rule parts shall be manufactured from materials and by processes that do not cause a hazard to personnel or hardware.

For the purpose of this standard hazardous materials are solids, liquids, or gases that can harm people, other living organisms, property, or the environment

It should be noted that when placed together, large quantities of normally non-hazardous materials may form a hazard. These shall be treated as hazardous.

Hazardous materials shall be avoided or substituted. If their use is unavoidable, they shall be identified in the Hazard Analysis and any subsequent hazards mitigated.

If the use of hazardous materials is required they shall be labelled and well protected and/or sealed. Material Safety Data Sheets must be provided in advance of delivery for all hazardous materials, as well as the specific procedures applicable to operate and service the concerned item(s) in the presence of such materials (specific protections).

5.2.10 Prohibited Materials

Any material which is prohibited for use under European or Chilean law shall not be used.

5.2.11 Galvanic compatibility

When bimetallic contacts are used, the choice of the pair of metallic materials used shall be fully assessed on a case-by-case basis and documented.

When bimetallic contacts are used across external interfaces they shall be fully assessed and agreed by ESO.

N.B. This also includes metal-to-conductive fibre-reinforced materials contacts.



5.3 Materials Traceability

Materials traceability shall be applied to parts, materials or products that meet either of the classifications defined in sections 4.2.1.1 or 4.2.1.2 in accordance with their relevant requirements.

5.4 Part Identification

Parts shall be identified and where possible marked by the parts unique reference and serial number to provide traceability and configuration control.

This becomes necessary for example when:

- There is an incident or non-conformance
- For the purposes of technical investigations following failure or damage
- To reconstruct the parts history, either individually (individual traceability) or by the serial number in the case of batch manufacturing (lot traceability).
- For the exchange of spare parts



6 ESO Standard Parts

The following subsections details commonly used parts (nuts, screws, washers, etc.) which ESO deems to be standard and shall therefore be used wherever and whenever possible.

6.1.1 Nuts

Description	Standard	Strength category or Material
Hexagon Nuts		
Hexagon nuts, style 1 -- Product grades A and B	ISO 4032	8, A2, A4
Hexagon thin nuts (chamfered) -- Product grades A and B	ISO 4035	04, A2, A4
Hexagon nuts, style 1, with metric fine pitch thread -- Product grades A and B	ISO 8673	8, A2, A4
Hexagon thin nuts (chamfered) with metric fine pitch thread -- Product grades A and B	ISO 8675	04, A2, A4
Hexagon Nuts - With Flange		
Hexagon nuts with flange -- Coarse thread	ISO 4161	8, A2, A4
Hexagon collar nuts with a height of 1,5 d	DIN 6331	8, A2, A4
Cap Nuts		
Hexagon domed cap nuts, high type	DIN 1587	6, A2, A4
Hexagon cap nuts, low type	DIN 917	6, A2, A4
Hexagon Nuts - Slotted		
Hexagon slotted and castle nuts - Part 1: Metric coarse and fine pitch thread; Product grades A and B	DIN 935-1	8, A2, A4
Hexagon slotted nuts - Part 3: Metric coarse pitch thread; Product grade C	DIN 935-3	8, A2, A4
Hexagon thin slotted and castle nuts - Metric coarse and fine pitch thread - Product grades A and B	DIN 979	04, A2, A4
Round Nuts		
Knurled nuts, low type	DIN 467	5, 1.4305
Rolling bearings - Locknuts	DIN 981	A2, A4
Wing Nuts		
Wing nuts, rounded wings	DIN 315	GT, A2, A4
Other Nuts		
Lifting eye bolts	DIN 580	C 15E, A2, A4
Lifting eye nuts	DIN 582	C 15E, A2, A4

Table 2 - ESO Standard Nuts



6.1.2 Screws

Description	Standard	Strength category or Material
Hexagon Head Bolt		
Hexagon head bolts -- Product grades A and B	ISO 4014	8.8, 10.9, A2, A4
Hexagon head screws -- Product grades A and B	ISO 4017	8.8, 10.9, A2, A4
Hexagon head bolts with metric fine pitch thread -- Product grades A and B	ISO 8765	8.8, 10.9, A2, A4
Hexagon head screws with metric fine pitch thread -- Product grades A and B	ISO 8676	8.8, 10.9, A2, A4
Countersunk		
Slotted countersunk flat head screws -- Product grade A	ISO 2009	4.8, A2, A4
Hexagon socket countersunk head screws	ISO 10642	8.8, A2, A4
Countersunk flat head screws (common head style) with type H or type Z cross recess - - Product grade A -- Part 1	ISO 7046-1	4.8
Cross recessed countersunk (flat) head tapping screws	ISO 7050	Steel, A2, A4
Round Head		
Pan head screws with type H or type Z cross recess -- Product grade A	ISO 7045	4.8, 8.8
Cross recessed pan head tapping screws	ISO 7049	A2, A4
Set Screws		
Slotted set screws with cone point	ISO 7434	14H, A2, A4
Slotted set screws with long dog point	ISO 7435	14H, 1.4305
Slotted set screws with cup point	ISO 7436	1.4305
Slotted set screws with flat point	ISO 4766	14H, A2, A4
Hexagon socket set screws with flat point	ISO 4026	45H, A2, A4
Hexagon socket set screws with cone point	ISO 4027	45H, A2, A4
Hexagon socket set screws with dog point	ISO 4028	45H, A2, A4
Hexagon socket set screws with cup point	ISO 4029	45H, A2, A4
Studs		
Studs - Metal end $\approx 2 d$	DIN 835	5.8, A2, A4
Studs - Metal end $\approx 1 d$	DIN 938	8.8, A2, A4
Studs - Metal end $\approx 1,25 d$	DIN 939	8.8, A2, A4
Socket Head		
Hexagon socket head cap screws	ISO 4762	8.8, 10.9, A2, A4
Hexagon socket head cap screws with low head	DIN 7984	8.8, 10.9, A2, A4
Hexagon socket head cap screws with centre, with low head	DIN 6912	8.8, 10.9, A2, A4
Slotted cheese head screws -- Product grade A	ISO 1207	4.8, 8.8, A2, A4

Table 3 - ESO Standard Screws



Screws that are needed for the fixation of COTS components that are only available in imperial sizes are permitted to be used.

6.1.3 Washers

Description	Standard	Strength category or Material
Plain		
Plain washers -- Normal series -- Product grade A	ISO 7089	200HV, A2, A4
Plain washers -- Small series -- Product grade A	ISO 7092	140HV, A2, A4
Washers for steel structures - Part 1: Product grade C	DIN 7989-1	100HV, A2, A4
Washers for steel structures - Part 2: Product grade A	DIN 7989-1	100HV, A2, A4
Spring		
Conical spring washers for bolted connections	DIN 6796	Spring steel, A2, A4, BeCu

Table 4 - ESO Standard Washers

The DIN 6797, DIN 6798, and DIN 128 spring washers shall not be used unless absolutely unavoidable and approved in writing by ESO.

6.1.4 Pins

Description	Standard	Strength category or Material
Cylindrical		
Parallel pins, of unhardened steel and austenitic stainless steel	ISO 2338	Steel, A4
Parallel pins, of hardened steel and martensitic stainless steel (Dowel pins)	ISO 8734	Steel
Spring-type straight pins -- Slotted, light duty	ISO 13337	Spring steel
Grooved Pins		
Grooved pins -- Full-length parallel grooved, with chamfer	ISO 8740	Steel, 1.4305
Grooved pins -- Half-length reverse-taper grooved	ISO 8741	Steel, 1.4305
Grooved pins -- Full-length taper grooved	ISO 8744	Steel, 1.4305
Grooved pins -- Half-length taper grooved	ISO 8745	Steel, 1.4305
Taper Pins		
Taper pins, unhardened	ISO 2339	Steel, A4
Spring-type straight pins -- Slotted, heavy duty	ISO 8752	Spring steel, A2
Cotter Pins		
Split pins	ISO 1234	Steel, A2, A4

Table 5 - ESO Standard Pins



6.1.5 O-Rings

O-Rings sizes shall be selected in accordance with AD19.

The material of the O-Ring shall be suitable for the particular application it is intended to be used in as well as the environment. Particular consideration shall be taken with regard to UV, Ozone, and the low humidity levels experienced at Observatory locations.

For vacuum and cryogenic applications Viton O-Rings shall be used.

Acrylonitrile-Butadiene-Rubber (NBR) O-Rings shall not be used.

6.1.6 Retaining Rings

Description	Standard	Strength category or Material
Retaining rings for shafts - Normal type and heavy type	DIN 471	Spring steel
Retaining washers for shafts	DIN 6799	Spring steel
Retaining rings for bores - Normal type and heavy type	DIN 472	Spring steel

Table 6 - ESO Standard Retaining Rings

ISO 464 and DIN 7993 type Snap Rings shall not be used unless absolutely unavoidable and approved in writing by ESO.

6.1.7 Gears

Gears are treated as a spare part item and are to be identified in the spare parts list.

6.1.8 Bearings

Bearings are treated as a spare part item and are to be identified in the spare parts list.

6.1.9 Keys

Description	Standard	Strength category or Material
Drive Type Fastenings without Taper Action; Parallel Keys, Keyways, Deep Pattern	DIN 6885-1	Steel, A4
Drive Type Fastenings without Taper Action; Parallel Keys, Shallow Pattern, Dimensions and Application	DIN 6885-3	Steel, A4
Drive Type Fastenings without Taper Action; Woodruff Keys, Dimensions and Application	DIN 6888	Steel, A4
Woodruff keys and keyways	ISO 3912	Steel, A4

Table 7 - ESO Standard Keys and Keyways



6.1.10 Couplings

Couplings are treated as a spare part item and to be defined in spare parts list.

6.2 Selection of Parts that are not ESO Standard

Non standard ESO Parts shall be chosen giving preference to the following:

- Those successfully used for an identical application with respect to environment constraints and lifetime to the proposed application
- Those for which satisfactory evaluation results are obtained on samples representative of the application with a sufficient margin as regards conditions of use
- Those recommended from internationally recognised data sources.

Whether the parts are already validated or remain to be validated, their selection shall take into account the following criteria:

- Continuity of supply and preferably local availability at the country where the unit will be finally installed.
- Reproducibility of characteristics
- Parts shall be selected in accordance with proven international or national Standards as far as possible.
- The use of COTS parts and components is strongly encouraged
- Where custom solutions are selected, justification shall be provided (in relation to cost, schedule, performance, or a combination thereof) and the selection of such solution shall be supported by a documented trade-off.
- Where custom solutions are selected, the Contractor shall provide a clear and realistic plan for managing obsolescence, allowing ESO to purchase the necessary services in a competitive environment.
- Only high quality, long-life components shall be used. Long-life is meant to cover the specified lifetime of the system as a minimum.



7 Specific ESO Design Requirements

The design shall meet all relevant and necessary safety and design requirements and standards, specific to the country in which the product will be used. If the product is to be used in multiple countries then the most stringent requirements and standards shall apply.

Wherever applicable seismic conditions shall be considered in accordance with the relevant environmental specification to where the product will be finally used.

All life cycle phases of the product shall be considered, for example transportation, testing, handling, operation, etc..

7.1 Structural Design

The structural design principles, methods, and requirements as stipulated in the Eurocodes (AD8, AD9, AD10, and AD11) shall be used.

7.2 Bolted Joints

The criticality of the joint, assembly and re-assembly requirements, maintainability, possibility to inspect, cost and other criteria shall be considered.

Each bolted connection needs to be assessed against unintended opening and a proper solution chosen and documented.

The preferred solution is a preloaded bolted connection, designed according to RD3 and torqued properly.

Bolted connections, where a torque different to the torque recommended by the norm is necessary shall be clearly and durably marked on the equipment in each instance.

Other commercial products such as lock-nuts, anaerobic glues (e.g. Loctite), specialised washers such as rip-lock etc. can be used when they fulfil all requirements and shall be specified on the drawings.

Any plastic material must be compatible with the environment in which it will be located, for example able to resist high UV and ozone levels on the observatories as specified in the relevant environmental specifications.

The reuse of lock-nuts shall be specified in the maintenance instructions.

For vacuum and cryogenic equipment special requirements apply which are not within the scope of this standard.

Heavy duty bolted joints must be identified and verified in the technical documentation.



7.3 Piping Systems

Piping systems shall be designed in accordance with the applicable standard (International or National depending on availability) but there are a number of exceptions and additional requirements that shall be applied, namely:-

- Wherever possible, metallic fixed tubes are preferred over flexible tubes.
- Piping should be designed to discourage its use as a step or ladder. External loads should not be imposed upon piping.
- Piping shall not be used to support components where they would impose undue loads on the piping. Undue loads may arise from component mass, shock, vibration and surge pressure.
- Every connection to piping should be accessible for tightening without disturbing adjacent piping or equipment, particularly where piping terminates in a cluster of fittings.

7.3.1 Definition of Nominal Sizes

Pipe diameter Nomenclature shall be accordance with AD27.

The DN size shall be quoted in all cases and assumed to be the specification, but the inch size can be quoted as additional information only.

These are the basic nominal size values that shall be used for all documents and information of ESO projects.

DN	8	10	15	20	25	32	40	50	65	80	100	125
Inch	¼"	⅜"	½"	½"	1"	1 ¼"	1 ½"	2"	2 ½"	3"	4"	5"

Table 8 - Standard Nominal Diameters for ESO piping systems

7.3.2 Labelling

Labels shall be in English and Spanish.

Labels shall be used for all LRU items.

Labels shall be positioned so that they can be easily seen.

Labels are required at the following locations:

- Adjacent to all valves and flanges.
- Adjacent to all changes of direction.
- On both sides of wall or floor penetrations.

Contractors shall mark valves and actuators to indicate their function, normal position, and other information. Since few valves offer a flat surface for a label to adhere to, hanging tags are frequently used. Valve tags can help improve efficiency and avoid accidents by eliminating confusion, especially in crowded environments.

Labels shall be able to withstand the environment in which they are situated.

If labels have a limited life in the environment in which they are situated then they shall be spare part.



7.3.2.1 Couplings for diagnostics purposes

Test points shall be installed at all locations where bleeding is required during operation and maintenance, and where access to the system is needed for testing and trouble shooting. Especially in all circuits where pressure levels are controlled by adjustable valves.

Test points shall be installed to check and re-set the correct pressure level.

7.3.3 Calibration of Measuring Devices

In addition to section 7.6 of AD21, all valves and other devices which carry an adjustment or setting to allow calibration, the following shall be provided:

- Units that have been calibrated shall be clearly labelled with the set value.
- The calibration procedure document number shall be included on the label.

Instructions shall be provided for the re-adjustment of the calibration.

7.3.4 Pipe Hangers and Supports

Pipe hangers and pipe supports include clevis hangers, beam clamps, pipe clamps, brackets, pipe straps and other accessories that hold or support pipes in place.

Pipe hangers are used as anchor points and shall be designed to take into account vibrations and control expansion.

Temporary supports shall be used during pipework installation to prevent overstressing the pipe work. These temporary supports are to be removed from site after completion of the installation.

Where performance or safety of any system (e.g. telescope, instrument or enclosure) may be adversely affected by vibrations, vibration sources shall be avoided as much as reasonably possible, and dampers be used to mitigate vibration propagation

7.4 Hydraulic Oil Systems

7.4.1 General Requirements

Oil Hydraulic systems shall be designed according to AD21. This international standard is intended as a guide for suppliers and ESO, with a view to ensuring safety, uninterrupted system operation, ease and economy of maintenance and a long life of the systems.

7.4.2 Pipe and Tubing Materials

Pipes and tubes for hydraulic applications shall be made from carbon steel.

Stainless steel pipes and tubes can only be used when unavoidable.



7.4.3 Connections

7.4.3.1 Threads

For Hydraulic systems ESO has defined the following standard threads:

- Straight threads shall be in accordance with AD13.
- Tapered threads shall be in accordance with AD12 .

BSPP threads shall be used in preference to NPT.

7.4.3.2 Flanges

Flanges shall be in accordance with AD28.

7.4.4 Fittings

7.4.4.1 Standard Fittings

For Hydraulic systems ESO has defined the following standard fittings

- Normal fittings: Parker A LOK threads
- Precision fittings: Swagelok

The standard material for Hydraulic fittings is steel.

7.4.4.2 Quick Couplings

Self-sealing quick connectors shall be in accordance with AD29.

For Special cases and high pressures connectors shall be in accordance with AD34.

7.4.4.3 Strainers

For strainers the sieve shall be removable and made from stainless steel.

7.4.4.4 Filters

Filters shall be selected according to the cleanliness requirements of the system.

All filters shall include an indicator to show when the filter is contaminated beyond functional use. This indicator shall be at the operator's location for manually controlled systems and shall be available as control signal for remotely controlled systems.

Filters shall be able to be replaced without causing contamination of surrounding components or systems.

In critical operational systems dual redundancy filters shall be used.



7.4.4.5 Sealing

PTFE (Polytetrafluoroethene) tape shall only be used where possible contamination of the system will not have any detrimental effect.

In general pipe-end fittings shall be made with body sealing and bite rings, not through a pipe thread.

7.4.4.6 Couplings for diagnostics purposes

Test points in the hydraulic system shall use the components of the series MINIMESS from Hydrotechnik (see RD4) or equivalent.

The hydraulic couplings for diagnostics purposes and the connection points shall comply with AD31.

7.5 Pneumatic Systems

7.5.1 General Requirements

Pneumatic Air systems shall be designed in accordance with AD22.

7.5.2 Threads

Threaded parts for pneumatic air systems shall conform to the following:

- Straight threads shall be in accordance with AD13.
- Tapered threads shall be in accordance with AD12 .

7.5.3 Tubing

Tubing shall be a heat and light stabilised material which meets or exceeds the requirements of AD6, AD2, or CETOP RP54P requirements.

Steel tube dimensioning shall be in accordance with AD20.

Standard material for flexible tubing is polyamide Nylon tubing for a temperature range from -40°C up to +100°C (in accordance with AD7)

The preferred outer diameter for tubing is 6mm.



7.5.4 Fittings

7.5.4.1 Standard Fittings

ESO Standard pneumatic fittings are shown in Table 9 below.

Application	Manufacturer	Product
Fittings	FESTO	Series QS, polyurethane (PUN)

Table 9 - Pneumatic Fittings

7.5.4.2 Quick Couplings

ESO Standard quick couplings are shown in Table 10 below.

Application	Manufacturer	Product
Quick connect couplings	RECTUS	Type 25

Table 10 - Pneumatic Quick Couplings

7.5.4.3 Valves

Valve terminals shall be in accordance with AD25.

When in 18 and 26 mm widths they shall be in accordance with AD33.

7.5.4.4 Exhausts

The peak noise level generated by pneumatic exhausts shall be no greater than 80 dB.

The level of contamination shall be no greater than that of the incoming compressed air supply.

Exhaust air must be ducted away from the unit in such a way that there is no possibility to disrupt air flow in optical beams or disturb dust particles.

An exhaust shall not interfere with the intake of any other intake.

Compressed air quality requirements will be specified in terms of ISO 8573.1. Additionally, every application will have to clearly indicate the minimum operating pressure.

Every system that works with compressed air will be furnished with isolation valves, drain legs, and test points where needed.

7.5.4.5 Couplings for diagnostics purposes

For compressed air systems, especially at the inlet of the sub-systems and upstream of the solenoid valves of critical components, couplings for diagnostics purposes shall be provided.



The standard type to be used shall be Pete's Plugs which will also allow monitoring of the air quality at each point of use.

7.6 Nameplates and Product Marking

Contractor manufactured parts, purchased parts modified by the contractor, and all parts identified in the spare parts list shall be marked or equipped with identification plates. The only exceptions shall be standard parts (e.g. fasteners, washers, pins, etc.)

The markings and identification plates shall be visible after installation and shall contain the following information:

- a) Part number (see section 5.4)
- b) Serial number
- c) Year of manufacture
- d) Name of manufacturer

7.7 Consumables

7.7.1 Lubricants

The following lubricants are in use at the ESO observatories and shall be used:

Application	ISO specification	Supplier/Brand	Product
Hydraulic Oil	VG 22	Mobil	DTE 12M (Existing systems)
		Mobil	DTE 10 Excel (New systems)
		Shell	Tellus T46
		Castrol	BRICO MICRONIC 783
Gear box oil	VG 220	Mobil	SHC 630
		Mobil	Glygoyle 30
Grease		Optimol	Opticoating TF
		Kluber	Kluberplex BEM 34-132
		Chesterton	Grease 613 - MoS3
		Mobil Glygoyle 30	Glygoyle 30

Table 11 - ESO Preferred Lubricants