20.1 Functions, Basic Configuration and System Boundaries

20.1.1 Functions

The function of the diagnostic system is given in DRG 1, section 2.17.

The diagnostics system shall have the capability to measure all plasma parameters necessary to operate and understand the behaviour of the ITER plasma in all phases of the pulse and also during expected deviations from the planned scenario.

In particular the diagnostics system providing the measurements in Category 1a) for machine protection and basic plasma control, Category 1b) for control of plasmas in specific high performance scenarios); and Category 2 for understanding important physical phenomena which may limit ITER performance.

Category (1a)
The most important function of the ITER Diagnostic System is to provide measurements for machine protection and basic plasma control. The measurements will be used by the ITER Plasma Control System to maintain operation in the required regime and to protect important machine components. The principal components to be protected are the vacuum vessel, divertor, other in-vessel components and the vacuum boundary. Measurements in this category will provide the machine protection and basic plasma control. They will be available for all high performance ITER pulses and will be used in the real-time control of these pulses. Measurements in Category (1a) are essential for ITER Operation.

Category (1b)
The function of the measurements in this category is to provide the opportunity for advanced plasma control to achieve high levels of performance under specific conditions. In addition these measurements will be used to evaluate and optimise the plasma performance. Measurements in this category are required to be available for all high performance ITER pulses and to be potentially available for control.
Measurements in Category (1b) are essential for ITER Operation.

Category (2)
It is inevitable that physical phenomena will limit the performance of ITER and this category of measurements will provide additional information which will hopefully lead to a better understanding of the phenomena involved and possibly improved performance.

The ITER diagnostic system shall have capability to allow study of the physics of sustained burn and of long pulse operation assisted by non-inductive current drive.

Comprehensive plasma diagnostic information shall allow attainment and monitoring of reliable modes of operation. In particular, operating modes with high levels of plasma power and thermal energy must, once initially obtained, be highly reproducible and have an acceptably low frequency of major disruptions and/or abnormal termination of plasma operation.

The ITER Diagnostic System must provide measurements of the required parameters in appropriate parameter ranges and with resolutions and accuracy sufficient for the intended applications. Consideration of the latter leads to the specific requirements for Categories (1a) and (1b) measurements as shown in DRG1, Table 1.13-2.

20.1.2 Basic Configuration and System Boundaries

The diagnostic system is comprised of 46 individual measurement systems. The components of the diagnostic systems are installed in the vacuum vessel, the upper, equatorial and divertor ports, and in the divertor cassettes. For some systems, transmission lines pass signals through the port shielding plugs, interspace blocks, cryostat, pit and the buildings to remote diagnostic hardware installed in the diagnostic hall. The system is operated through the ITER Command Control and Data Acquisition system (CODAC).

20.2 Specific System Internal Requirements

20.2.1 Vacuum

a) Diagnostic equipment situated inside the vacuum vessel and extensions shall be compatible with base vacuum partial pressures, outgassing rates, global leak rates, and bakeout temperatures specified in DRG1, section 1.23.

b) All diagnostic penetrations of the vacuum vessel shall be compatible with the requirement for two robust tritium confinement barriers, as specified in Plant Safety Requirements (PSR), section 3.11.

c) The capability shall be provided, as necessary, to allow the in-situ leak testing of diagnostic components on the primary and secondary vacuum boundaries, as specified in Vacuum Design Handbook, section 3.3.

d) The in-vessel diagnostic components shall be bakeable for Torus conditioning to the maximum temperature consistent with a coolant temperature below saturation for the design pressure of primary cooling systems. The maximum baking temperature will be 240° C, as specified in DRG1, section 1.22.

e) Diagnostic components shall be protected where necessary from the sputtering and deposition effects of glow discharge cleaning with hydrogen and other gases (with no toroidal field), as specified in DRG1, section 1.22.

f) Diagnostic components in the vacuum vessel shall be compatible with venting with dry air or nitrogen in 2 to 10 hours.

g) Where required, guard vacuum volumes around diagnostic equipment shall be provided capable of maintaining primary vacuum and secondary vacuum interspaces at a pressure of ~1 Pa. Connections shall be provided from these volumes to the guard vacuum pumping system.

h) Pumping and control systems compatible with the requirements of the various diagnostics shall be provided for diagnostic equipment requiring vacuum conditions.

20.2.2 Confinement

a) The systems shall meet the requirement for the vacuum vessel to provide a continuous welded wall for tritium confinement and a double vacuum boundary with leak test capability at all vulnerable boundaries, including windows, as specified in Plant Safety Requirements (PSR), section 3.11.

b) Vacuum tight feedthroughs and windows are required in both the primary vacuum boundary and the secondary vacuum boundary. These are preferably to be located at the main vacuum boundary component (e.g., port seal plate or cryostat door). Where it is necessary for diagnostic function, RH accessibility or increased reliability, these boundaries may be extended with local tubes.

c) For all diagnostic systems which require an unobstructed straight-through view of the plasma such as the neutral particle analyser, vacuum U-V and X-ray spectroscopy, the double confinement shall be preserved everywhere with a separately differentially pumped monitored guard volume.

d) It is required that the primary vacuum boundary is all metal, fully welded construction designed to withstand an internal pressure of 0.2 MPa (2 bar) at operating temperature without failure. The secondary boundary is designed for vacuum or operation at reduced pressure 0.2 Mpa. The capability of vacuum is a requirement for leak testing, whatever the final chosen operating pressure of the interspace.

e) The minimum cross sectional area of windows and other equipment closure shall not exceed 0.02 m^2. This requirement is to minimise the gas flow through the aperture in the event of a failure, as, for instance, a loss of cooling accident (LOCA). If the window or equipment closure is attached to the end of a large diameter extension or sleeve, required for remote welding operations, the window or vulnerable component area shall also be kept to a minimum.

f) It is required that all primary vacuum boundaries will be sufficiently robust to withstand all foreseeable accident or fault conditions, including possible failure or loss of control of remote handling tools. Where possible, bellows and moveable joints are to be avoided.

g) A system of automatic valves is required to protect the main vacuum from failures of the diagnostic systems and to allow local repairs without affecting the main torus operation. These systems will be required to have separate pumping systems with an exhaust into the service vacuum system

20.2.3 Structural

a) Structural design of diagnostic system shall be performed in accordance with the Structural Design Criteria (SDC), in particular volume 1, In-vessel Components (SDCIV).

b) The diagnostic equipment and components of each system shall be designed to withstand and operate in and under loads as specified in Load Specification and Combination .

c) The diagnostic equipment shall be designed to retain its vacuum integrity function after off-normal events as classified in Plant Safety Requirements (PSR). These off-normal events include:

i) Vacuum Vessel pressurised by steam up to 0.2 MPa.

ii) Internal Cryostat volume pressurised up to 0.2 MPa.

d) Holes required for plasma observation shall be designed such that local stresses remain within design limits.

20.2.4 Electromagnetic

~~a) Expected characteristics of disruptions and VDEs are given in DRG1, section 1.16 and Load Specification and Combination~~.

b) The design must allow for major disruptions and VDEs according to the expected number and characteristics of these events as given in the DRG1. ~~. For design guidelines, it should be assumed that there will be about 3300 disruptions, with about 3000 disruptions at nominal parameters with 54 ms current quench, 300 at full current with 27 ms current quench.~~

c) The design is required to include a detailed assessment of the electromagnetic forces associated with both the normal and also the transient electromagnetic forces. These forces can be reduced where necessary by constructing the systems with well protected electrically insulated breaks in order to minimise the induced eddy currents during disruptions.

20.2.5 Thermohydraulic

a) Expected static and dynamic heat loads on the First Wall are given in DRG1, section 1.15. Actual thermal loads on diagnostic components from all sources, including bulk nuclear heating and decay heat, must be determined on a case-by-case basis, taking into account protection afforded by surrounding equipment.

b) Active cooling will be required for components which receive substantial fluxes of thermal and ionizing radiation. (e.g. diagnostic block, poloidal field pick up coils, bolometer heads, etc.). A detailed calculation of both the thermal loads and the cooling design is required for all susceptible components.

c) Cooling for diagnostic components inside the biological shield shall be derived from the cooling circuits of major machine components. ~~and be designed to operated at nominal inlet temperature of 100 °C and at maximum outlet temperature of TBD~~.

20.2.6 Mechanical

a) Mechanical structure for diagnostic components shall satisfy design criteria specified in Structural Design Criteria (SDC), in particular volume 1, In-vessel Components (SDCIV).

b) Mechanical vacuum feedthroughs shall satisfy criteria specified in Plant Safety Requirements (PSR).

c) Mechanical stresses in vacuum windows shall be minimised to avoid breakage. Window assemblies shall be designed so as to minimize consequenes of failure.

d) Diagnostic equipment shall incorporate automatic compensation of differential movements as described in DRG1, section 1.21. In particular the movement between vacuum vessel and cryostat (thermal and operational) and between cryostat, pit structure and gallery (earth quake) must be compensated.

e) Diagnostic equipment shall not obstruct the access for remote handling operations as described in DRG1, section 1.26. Preferably it shall be located on platforms in the pit area outside the volume needed for operation of the RH casks. If necessary and unavoidable, equipment can be mounted on removable trolleys.

20.2.7 Electrical

a) Diagnostic electrical equipment shall conform with the relevant Recommendations published by the International Electrotechnical Commission (IEC).

b) Diagnostic components shall be designed so as to prevent large induced currents and arcs during normal and off-normal events.

c) In moderate vacuum environment (e.g. interspace cryostat-vacuum vessel) special care shall be taken to avoid pressures in the range of the Paschen minimum. Electrical connections and wires in such areas shall be provided with extra insulation.

d) Junction boxes shall be provided in the pit, between ports (gallery walls) and attached to any discrete diagnostic systems for easy removal or alteration.

e) Cabling within the Vacuum Vessel will be regarded as permanent and designed to outlive the vacuum vessel. It shall be robust enough to withstand both installation and use.

Although the cabling will not be remotely maintainable the design must demonstrate the procedures required to support sector removal and replacement.

f) The installation of all in-vessel cabling shall be designed to best match the assembly sequence of the Vacuum Vessel, Ports, Blanket Modules, Divertor Cassettes & Port Flanges when all factors such as installation time, protection requirements, installation cost are considered.

g) Large electrically closed conducting loops shall be avoided to prevent the generation of high induced currents and arcing.
h) The design operating pressure within interspaces and guard vacuum shall take full account of electrical installations to ensure that voltage breakdown will not occur during normal operating conditions.

Power Supply Requirements

i) The use of class 1 and class 2 uninterruptible supplies described in Plant Safety Requirements (PSR) shall be limited to the maximum extent possible consistent with providing the necessary safeguards for equipment and the prevention of safety hazards arising from power failure.

j) All components that use electrical power and perform a protection function shall use class 1 and class 2 uninterruptible supplies. In particular all diagnostic systems used for machine protection and plasma control shall use uninterruptible supplies. Power supplies for other diagnostic systems can be class 3.

20.2.8 Nuclear

In ITER, neutron and gamma shielding of the radiating, ignited core is required to reduce the nuclear heating of the super-conducting PF and TF coils to acceptable levels and to reduce the neutron flux to the vacuum vessel joint region to guarantee its re-weldability over the full life time of the machine. The reduction of total neutron flux is achieved by the blanket with an attenuation of $\sim 10^{-2}$ and by the vacuum vessel with an attenuation of $\sim 10^{-3}$ under the assumption that both structures are continuous.

Diagnostic systems require a view on the plasma and therefore a hole in the neutron shielding with dimensions dependant on the nature of the diagnostic. The design requirement is that any penetration should not allow more neutron radiation to escape than is equal to that which would escape through the uninterrupted combined shielding of blanket, back plate and vacuum vessel. This is mainly achieved by minimising the size of the hole in the blanket in relation to the required solid angle for viewing and by introducing labyrinths (dog-legs) combined with long ducts in the diagnostic shielding block. For small holes (diameter ≤ 100mm) a double bend labyrinth is sufficient; for large holes (diameter ≤ 300mm) a triple bend has been found to be necessary. The dimensions of large holes and extended slits in the blanket and back plate are limited by the re-weldability requirements of the vessel. For some diagnostics a straight through hole is required. First the size of the hole is minimised in relation to the required solid angle for viewing. Secondly, shielding around the detector is provided in combination with shielding around the duct and double confinement.

a) The main vessel and the in-vessel components together shall provide sufficient nuclear shielding capabilities to protect the super-conducting coils in accordance with DRG1, section 1.17.

   Exposure of field weld to vacuum vessel must be limited to below 1 appm He for 0.5 $MWa.m^{-2}$ at the first wall.

   The diagnostic design shall include additional shielding to compensate for any shielding removed to accommodate diagnostic components or for plasma access so that these requirements are met.

b) ITER diagnostics shall incorporate radiation shielding to permit personnel access ~~in the annular space~~ outside the bioshield. Shielding shall be designed to allow plant worker to access those area 24 hours after shutdown. The level of ionising radiation shall be 10 μSv/hr.
c) When a penetration through the blanket and VV shielding is required, the effect of radiation streaming must be mitigated by compensating shielding as close as possible to the VV location as required inDRG1, section 1.17.

d) If nuclear or magnetic shielding is required, the shield shall be designed as part of the diagnostic equipment.

e) The radiation level in the cryostat space of the diagnostic ports following operation is to be less than 100 μSv/hr 10^6 s after shutdown. This requirement is to allow hands-on access to the cryostat inter-space following machine shutdown. The diagnostic design shall include additional shielding to compensate for any shielding removed for diagnostic components or for plasma access, in order to meet this requirement.

f) Where diagnostic components such as electronic systems are permanently installed inside the cryostat space of the diagnostic ports additional shielding shall be provided to prevent damage or activation of the diagnostic systems caused by the removal of radioactive components from any adjacent ports. The shielding design criteria should include the effects of possible fault conditions which may increase the duration of exposure.

20.2.9 Remote Handling

a) The ITER diagnostic system shall incorporate maintainability features in the design which are consistent with achieving the mission reliability, operational availability, and scheduled maintenance requirements stated below. Possibility and optimization of hands-on maintenance shall always be considered first; hands on assistance shall be considered in remote handling procedures as required in DRG1, section 1.26.

b) The ITER diagnostic systems and components shall be designed to minimize remote maintenance, and ITER components that require remote maintenance shall be designed for remote handling.

c) Removal of radioactive components from inside the vessel will make use of transfer casks to bring them to the hot cell through the dedicated ports of the machine.

d) Diagnostic equipment located inside the vacuum or cryostat vessel shall be capable of being maintained and/or replaced by using remote maintenance equipment at the hot cell.

e) Maintenance and/or replacement of diagnostic equipment must have the minimum impact on ITER operation.

f) All major component repair requiring remote handling will be conducted in the hot cell diagnostic facility.

g) Major machine components (with diagnostic components attached) requiring remote maintenance shall be removed by the standardised remote handling techniques and transported to the hot cell where all diagnostic maintenance is executed by special tools. Most of the alignment, calibration and testing activities will also take place in this area.

h) All components mounted on the inside wall of the vacuum vessel are RH class 3. The diagnostic design is required to demonstrate that the lifetime of these diagnostic systems will exceed the planned operating lifetime of the ITER facility.

20.2.10 Chemical

Material used in the design of diagnostic systems shall not promote or support chemical reactions.

20.2.11 Seismic

Seismic loads for diagnostic systems and components shall be the same to those of in-vessel component specified in Load Specification and Combination.

20.2.12 Manufacturing

a) The systems shall be designed with components that are either already used in existing equipment or their satisfactory performance can be demonstrated before being installed in ITER. Where not possible, any developmental system or subsystem must be capable of RH replacement and must not be made necessary for machine control or protection.

b) All diagnostics components will be required to demonstrate full performance and to be sufficiently commissioned to demonstrate required performance for the planned lifetime of the diagnostic prior to installation.

c) All diagnostic equipment will be manufactured under a quality assurance plan and with quality control, which shall be followed the ITER Quality Assurance Manual. The appropriate levels of control and requirements for assurance will be defined in the specific diagnostic designs.

d) Spares shall be kept of all critical components.

20.2.13 Construction

a) The construction of the diagnostic components will followed by the construction plan of ITER.

b) The diagnostic components which are to be integrated in the blanket, vacuum vessel, and divertor shall be constructed ahead of critical path in the construction and assembly plans of these systems.

20.2.14 Assembly

a) Initial assembly of diagnostic components on major machine components shall be done in suitable clean conditions, such as the hot cell. In particular the diagnostic block and vacuum flange being one unit, shall be assembled/disassembled, aligned and tested (for mechanical integrity and operation and diagnostic function) prior to installation on the machine.

b) All assembly shall be performed in accordance with the requirements developed from the guidelines provided in the Vacuum Design Handbook.

20.2.15 Testing

a) All diagnostics should be fully tested whenever feasible, prior to installation and should be fully commissioned prior to the high activation phase. Where not feasible, individual components must have been tested sufficiently to demonstrate correct functionality.
b) In general, the following type of factory test shall be performed on individual components:
   - Dimension checks;
   - Pressure tests;
   - Vacuum compatibility tests;
   - Mechanical tests;
   - Electorical tests.

c) All on-site weld shall undergo leak test, and non-destructive examination on site as required by the applicable codes and standards.

20.2.16 Instrumentation and Control

a) All diagnostic equipment must be able to be operated remotely. The diagnostic system shall be under the supervisory control of CODAC system.

b) Real time control signals and fast on-line data analysis will be designed consistent with the design of CODAC system.

c) Top level interlocks of the diagnostic system shall be routed to the CODAC. These interlocks will be limited to those that monitor the operational status of the diagnostic system, will affect other systems or discharge sequence interlock function.

d) Top level alarm signals shall be routed to the CODAC. These alarms will be limited to those which require immediate corrective action to be taken for machine protection instance.

e) Each diagnostic system shall include a local control cubicles as part of its sub system that has necessary functional ability to operate the diagnostic system. Principal local control cubicle will interface with CODAC as the diagnostic control system. The interface with the CODAC shall be minimized.

20.2.17 Decommissioning

a) Where possible, the design of diagnostic system is based on the following criteria relevant to decommissioning;

- use of modular components for easy dismantling;
- segregating radioactive systems or components;
- designing to avoid contamination or allow easy decontamination;
- selection of construction materials to reduce activation products in materials subject to irradiation.

b) The diagnostic shielding blocks shall be designed to be re-usable. Diagnostic components inside the primary vacuum shall be replaced.

c) All records, "as-built prints", information and equipment pertinent to decommissioning shall be retained during the life of ITER together with plant characterisation data needed for dismantling purposes after deactivation.

20.2.18 Materials

a) Commercial materials shall be utilised to the maximum possible extent.

b) In some cases, special materials will be required. Material Properties Handbook will provide the properties of some of these materials.

Radiation Tolerant Components

c) The design of any component exposed to a significant radiation environment is required to demonstrate adequate performance to the maximum expected dosage and in the expected radiation field to the end of the components planned lifetime.

d) The design shall include use of rules contained in the Radiation Hardness Manual as described bellow.

e) The first mirrors of optical and microwave systems must be robust and adequately cooled.

f) Polycrystalline ceramics such as alumina (Al_2O_3) can be used as soon as a radiation attenuation factor of 10 below the first wall value has been reached. This conclusion is valid for insulators and mechanical supports.

g) Optical fibres for transmission of visible light can only be used outside the biological shield with an exception for the transmission in the range of 800-1400 nm, which is possible inside the cryostat volume but outside the primary vacuum boundary.

h) Quartz windows can be employed on the primary vacuum boundary and beyond without increased attenuation or excessive luminescence. Similarly, refractive optics can be so employed.

20.2.19 Operating

a) Operation of the diagnostic system needed for machine protection and basic machine control shall be extremely reliable and essentially have a 100% availability, or have redundancy sufficient to guarantee good control against failures between relevant maintenance periods.

b) All diagnostic components placed in high radiation environment should be designed to operate in this environment for a period of up to next relevant maintenance session of the machine equipment on which the diagnostic component is installed.

20.2.20 Maintenance

a) The maintenance of diagnostic system components must comply with the maintenance requirements as specified in the DRG1 sect. 1.26.

b) In the pit at any upper and equatorial port, provision must be made for all diagnostic equipment to be removed clear for access to the biological shield plug within one week.

c) Planned maintenance of diagnostic system shall not require breaking the cryostat vacuum.

20.2.21 Other

Equatorial Port

Many factors have to be taken into account in determining the requirements for the optimum distribution of diagnostics in the equatorial ports.

a) Distributed systems should be located evenly toroidally. The location of some systems, (for example the in-vessel viewing systems), has to be co-ordinated with the location of corresponding systems in the upper ports.

b) Systems with complicated transmission lines, eg laser systems, should be located near the diagnostic hall (on the west side).

c) Direct coupled systems (NPA, VUV, X-ray crystal spec) should be installed in one sector location only if possible.

d) Multiple systems can be installed in one port but the integrated port must meet ITER shielding requirements. In practice this means that typically no more two systems with large labyrinths can be installed per port.

e) Some diagnostics can be installed on RH ports but there should be minimum impact on the time to deploy the RH equipment. In practice, there should be no physical connection between the VV seal plate and the cryostat and no interspace block to remove.

f) Charge eXchange Recombination Spectroscopy (CXRS) has to be able to view the DNB and MSE has to be able to view one of the heating NBIs.

g) Where diagnostics are required to be behind simple shielding, with no first wall aperture, they should be allocated to Limiters ports.

f) The possible positions for retroreflectors on the inboard and outboard walls, drive the positions of systems in the equatorial ports.

At each equatorial port

g) Large aperture systems should be positioned on the centre of ports, to maximise the neutron shielding to the main coils.

h) Tangential viewing systems should use the side of port, to minimise the amount of blanket shield module required to be profiled.

i) Where possible, diagnostic systems share a common gap in the Blanket Shield Module (BSM)

Upper Port

Many factors have to be taken into account in determining the requirements for the optimum distribution of diagnostics in the upper ports.

a) Distributed systems are located evenly in the toroidal direction. The location of some systems, for example the in-vessel viewing systems, has to be coordinated with the location of corresponding systems in the equatorial ports.

b) Systems with complicated transmission lines, e.g. laser systems, should be located on the west side near the diagnostic hall.

c) There should be no more than one high neutron throughput/ high viewing aperture system per port.

d) Charge eXchange Recombination Spectroscopy (CXRS) has to be above the DNB.

a) Motional Stark Effect spectroscopy (MSE) has to use one of the ports that can view one of the NB heating beams.

<u>Divertor and Cryo-pumping Port</u>

Divertor ports have to accommodate Diagnostics,Cryopumps, Gas & Fuel injection systems, Glow discharge cleaning electrodes, In vessel viewing, Maintenance detritiation systems and Remote Handling. These systems and equipment have their own requirements and guide lines. For diagnostics

a) Diagnostics which require heavy wiring such as bolometers, Langmuir probes should be distributed and as toroidally symmetric as possible to avoid overcrowded connectors in an instrumented cassette and a port.

b) Diagnostics which require large area of a divertor cassette or with a diagnostic block rack in the port, should be installed into the central cassette at the three Remote handling ports, #3, #9 and #15.

c) Diagnostics that require optical sight lines or microwave waveguides should be located on ‘optical cassettes’ central in a sector.

d) Diagnostic sensors and probes that require only electrical cables, and no optical sight lines or microwave waveguides, should be located on ‘instrumented cassettes’ to the sides of the central cassette.

e) Permanent wiring for these shoiuld be routed through cryo-pumping ports and Divertor RH ports.

The bolometers should be installed at the same toroidal location as the bolometers at the mid-plane but not on the same ports as the gas or pellet injection.

<u>Vacuum Vessel</u>

Locations for diagnostics on the VV wall must be compatible with the blanket and vacuum vessel. Specific changes to these should take into consideration cost effectiveness and structural integrity.

a) Permanent cabling in the VV should be installed within one sector and avoid interference with the VV field joint. Cabling mounted on the VV wall should be cooled by conduction to the vv wall

b) Retroreflectors required in the first wall should minimise their impact on the overall blanket design and on the immediately interfacing blanket modules.

c) Where possible the blanket segmentation gaps should be used for systems viewing the plasma.

d) Diagnostics with long continuous robust components (microwaveguides and neutron activation lines) should be situated at positions of in-situ field welds on the VV.

e) Cabling for VV diagnostics should exit the primary vacuum at the divertor level or upper ports

20.3 Codes and Standards

a) Codes and Standards will be applied in support of the design based on component function and safety importance classification. Where no appropriate codes or standards exist (for example in window design and manufacture), alternate approaches must be developed with supporting justification for the method used.

b) The source of material property information for design analysis shall be either the applicable structural code or the Material Properties Handbook.

c) The design shall include use of standards and design rules contained in the Radiation Hardness Design Manual and the Standards Design Criteria. The use of standard components, materials, and processes is required wherever reasonable. Exceptions to these manuals can be taken for appropriate technical or economic reasons, but these exceptions must be properly documented in the corresponding DDD.