

別添－１『イーター調達取決めに係る契約の品質保証に関する特約条項』

本契約については、契約一般条項によるほか、次の特約条項（以下「本特約条項」という。）による。

（定義）

- 第１条 本契約において「協定」とは、「イーター事業の共同による実施のためのイーター国際核融合エネルギー機構の設立に関する協定」をいう。
- ２ 本契約において「イーター機構」とは、協定により設立された「イーター国際核融合エネルギー機構」をいう。
- ３ 本契約において「加盟者」とは、協定の締約者をいう。
- ４ 本契約において「国内機関」とは、各加盟者がイーター機構への貢献を行うに当たって、その実施機関として指定する法人をいう。
- ５ 本契約において「フランス規制当局」とは、イーター建設地であるフランスの法令に基づき契約物品に関して規制、許認可を行う権限を有する団体をいう。

（品質保証活動）

- 第２条 乙は、本契約書及びこの契約書に附属する仕様書（以下「契約書等」という。）の要求事項に合致させるため本契約内容の品質を管理するものとする。

（品質保証プログラム）

- 第３条 乙は、本契約の履行に当たっては、乙の品質保証プログラムを適用する。このプログラムは、国の登録を受けた機関により認証されたもの（ISO9001-2015 等）で、かつ、本特約条項に従って契約を履行することができるものとする。ただし、これによることができないときは、甲により承認を得た品質保証プログラムを適用することができる。

（品質重要度分類）

- 第４条 乙は、適切な製品品質を維持するため、安全性、信頼性、性能等の重要度に応じて甲が定める本契約内容の等級に従って管理を実施しなければならない。契約物品の等級及び等級に応じた要求事項は、仕様書に定める。

（疑義の処置）

- 第５条 乙は、本契約書等に定める要求事項に疑義又は困難がある場合には、作業を開始する前に甲に書面にて通知し、その指示に従わなければならない。

（逸脱許可）

- 第６条 乙は、契約物品について、契約書等に定める要求事項からの逸脱許可が必要と思われる状況が生じた場合は、当該逸脱許可の申請を速やかに甲に提出するものとする。甲は、乙からの申請に基づき、当該逸脱許可の諾否について検討し、その結果を乙に通知するものとする。

(不適合の処理)

第7条 乙は、契約物品が契約書等の要求事項に適合しないとき又は適合しないことが見込まれるときは、遅滞なくその内容を甲に書面にて通知し、その指示に従わなければならない。

(重大不適合の処置)

第8条 乙は、重大不適合が発生した場合、直ちにその内容を甲に報告するとともに、プロジェクトへの影響を最小限に抑え、要求された品質を維持するため、その処置方法を検討し、速やかに甲に提案し、その承認を得なければならない。

(作業場所の通知)

第9条 乙は、本契約締結後、本契約の履行に必要なすべての作業場所を特定し、本契約に係る作業の着手前に、甲に書面にて通知するものとする。当該通知には、本契約の履行のために、乙が本契約の一部を履行させる下請負人の作業場所を含む。

(受注者監査)

第10条 甲は、乙に対して事前に通知することにより、乙の品質保証に係る受注者監査を実施できるものとする。

(立入り権)

第11条 乙は、本契約の履行状況を確認するため、甲、イーター機構、本契約の活動に関連する日本以外の加盟者の国内機関、フランス規制当局及びそれらから委託された第三者が、第9条に基づき特定した作業場所に立ち入る権利を有することに同意する。

2 前項に定める立入り権に基づく作業場所への立入りは、契約書等に定める中間検査等への立会い及び定期レビュー会合への参加の他、乙に対して事前に通知することにより、必要に応じて実施することができるものとする。

(文書へのアクセス)

第12条 乙は、甲の求めに応じ、本契約の適切な管理運営を証明するために必要な文書及びデータを提供するものとする。

(作業停止の権限)

第13条 甲は、乙が本契約の履行に当たって、契約書等の要求事項を満足できないことが認められる等、必要な場合は、乙に作業の停止を命じることができる。

2 乙は、甲から作業停止命令が発せられた場合には、可及的速やかに当該作業を停止し、甲の指示に従い要求事項を満足するよう必要な措置を講ずるものとする。

(下請負人に対する責任)

第14条 乙は、下請負人に対し、本契約の一部を履行させる場合、本特約条項に基づく乙の一切の義務を乙の責任において当該下請負人に遵守させるものとする。

(情報のイーター機構等への提供)

第15条 乙は、本契約の履行過程で甲に伝達された情報が、必要に応じてイーター機構及びフランス規制当局に提供される場合があることにあらかじめ同意するものとする。

以上

別添－２『本契約において遵守すべき「情報セキュリティの確保」に関する事項』

- 1 受注者は、契約の履行に関し、情報システム（情報処理及び通信に関わるシステムであって、ハードウェア、ソフトウェア及びネットワーク並びに記録媒体で構成されるものをいう。）を利用する場合には、量研機構の情報及び情報システムを保護するために、情報システムからの情報漏えい、コンピュータウィルスの侵入等の防止その他必要な措置を講じなければならない。
- 2 受注者は、次の各号に掲げる事項を遵守するほか、量研機構の情報セキュリティ確保のために、量研機構 が必要な指示を行ったときは、その指示に従わなければならない。
 - (1) 受注者は、契約の業務に携わる者（以下「業務担当者」という。）を特定し、それ以外の者に作業をさせてはならない。
 - (2) 受注者は、契約に関して知り得た情報（量研機構に引き渡すべきコンピュータプログラム著作物及び 計算結果を含む。以下同じ。）を取り扱う情報システムについて、業務担当者以外が当該情報にアクセス可能とならないよう適切にアクセス制限を行うこと。
 - (3) 受注者は、契約に関して知り得た情報を取り扱う情報システムについて、ウィルス対策ツール及びファイアウォール機能の導入、セキュリティパッチの適用等適切な情報セキュリティ対策を実施すること。
 - (4) 受注者は、P2P ファイル交換ソフトウェア（Winny、WinMX、KaZaa、Share 等）及び SoftEther を導入した情報システムにおいて、契約に関して知り得た情報を取り扱ってはならない。
 - (5) 受注者は、量研機構の承諾のない限り、契約に関して知り得た情報を量研機構又は受注者の情報システム 以外の情報システム（業務担当者が所有するパソコン等）において取り扱ってはならない。
 - (6) 受注者は、委任をし、又は下請負をさせた場合は、当該委任又は下請負を受けた者の契約に関する 行為について、量研機構に対し全ての責任を負うとともに、当該委任又は下請負を受けた者に対して、 情報セキュリティの確保について必要な措置を講ずるように努めなければならない。
 - (7) 受注者は、量研機構が求めた場合には、情報セキュリティ対策の実施状況についての監査を受け入れ、 これに協力すること。
 - (8) 受注者は、量研機構の提供した情報並びに受注者及び委任又は下請負を受けた者が契約業務のために収集した情報について、災害、紛失、破壊、改ざん、き損、漏えい、コンピュータウィルスによる 被害、不正な利用、不正アクセスその他の事故が発生、又は生ずるおそれのあることを知った場合は、直ちに量研機構に報告し、量研機構の指示に従うものとする。契約の終了後においても、同様とする。

なお、量研機構の入札に参加する場合、又は量研機構からの見積依頼を受ける場合にも、上記事項を遵守していただきます。

以上

知的財産権特約条項

(知的財産権等の定義)

第1条 この特約条項において「知的財産権」とは、次の各号に掲げるものをいう。

- 一 特許法（昭和34年法律第121号）に規定する特許権、実用新案法（昭和34年法律第123号）に規定する実用新案権、意匠法（昭和34年法律第125号）に規定する意匠権、半導体集積回路の回路配置に関する法律（昭和60年法律第43号）に規定する回路配置利用権、種苗法（平成10年法律第83号）に規定する育成者権及び外国における上記各権利に相当する権利（以下総称して「産業財産権等」という。）
- 二 特許法に規定する特許を受ける権利、実用新案法に規定する実用新案登録を受ける権利、意匠法に規定する意匠登録を受ける権利、半導体集積回路の回路配置に関する法律に規定する回路配置利用権の設定の登録を受ける権利、種苗法に規定する品種登録を受ける地位及び外国における上記各権利に相当する権利
- 三 著作権法（昭和45年法律第48号）に規定する著作権（著作権法第21条から第28条までに規定する全ての権利を含む。）及び外国における著作権に相当する権利（以下総称して「著作権」という。）
- 四 前各号に掲げる権利の対象とならない技術情報のうち、秘匿することが可能なものであって、かつ、財産的価値のあるものの中から、甲乙協議の上、特に指定するもの（以下「ノウハウ」という。）を使用する権利

2 この特約条項において「発明等」とは、次の各号に掲げるものをいう。

- 一 特許権の対象となるものについてはその発明
- 二 実用新案権の対象となるものについてはその考案
- 三 意匠権、回路配置利用権及び著作権の対象となるものについてはその創作、育成者権の対象となるものについてはその育成並びにノウハウを使用する権利の対象となるものについてはその案出

3 この契約書において知的財産権の「実施」とは、特許法第2条第3項に定める行為、実用新案法第2条第3項に定める行為、意匠法第2条第2項に定める行為、半導体集積回路の回路配置に関する法律第2条第3項に定める行為、種苗法第2条第5項に定める行為、著作権法第21条から第28条までに規定する全ての権利に基づき著作物を利用する行為、種苗法第2条第5項に定める行為及びノウハウを使用する行為をいう。

(乙が単独で行った発明等の知的財産権の帰属)

第2条 甲は、本契約に関して、乙が単独で発明等行ったときは、乙が次の各号のいずれの規定も遵守することを書面にて甲に届け出た場合、当該発明等に係る知的財産権を乙から譲り受けないものとする。

- 一 乙は、本契約に係る発明等を行った場合には、次条の規定に基づいて遅滞なくその旨を甲に報告する。
 - 二 乙は、甲が国の要請に基づき公共の利益のために特に必要があるとしてその理由を明らかにして求める場合には、無償で当該知的財産権を実施する権利を国に許諾する。
 - 三 乙は、当該知的財産権を相当期間活用していないと認められ、かつ、当該知的財産権を相当期間活用していないことについて正当な理由が認められない場合において、甲が国の要請に基づき当該知的財産権の活用を促進するために特に必要があるとしてその理由を明らかにして求めるときは、当該知的財産権を実施する権利を第三者に許諾する。
 - 四 乙は、第三者に当該知的財産権の移転又は当該知的財産権についての専用実施権（仮専用実施権を含む。）若しくは専用利用権の設定その他日本国内において排他的に実施する権利の設定若しくは移転の承諾（以下「専用実施権等の設定等」という。）をするときは、合併又は分割により移転する場合及び次のイからハまでに規定する場合を除き、あらかじめ甲に届け出、甲の承認を受けなければならない。
 - イ 子会社（会社法（平成17年法律第86号）第2条第3号に規定する子会社をいう。以下同じ。）又は親会社（会社法第2条第4号に規定する親会社をいう。以下同じ。）に当該知的財産権の移転又は専用実施権等の設定等をする場合
 - ロ 承認TLO（大学等における技術に関する研究成果の民間事業者への移転の促進に関する法律（平成10年法律第52号）第4条第1項の承認を受けた者（同法第5条第1項の変更の承認を受けた者を含む。））又は認定TLO（同法第11条第1項の認定を受けた者）に当該知的財産権の移転又は専用実施権等の設定等をする場合
 - ハ 乙が技術研究組合である場合、乙がその組合員に当該知的財産権を移転又は専用実施権等の設定等をする場合
- 2 乙は、前項に規定する書面を提出しない場合、甲から請求を受けたときは当該知的財産権を甲に譲り渡さなければならない。
 - 3 乙は、第1項に規定する書面を提出したにもかかわらず、同項各号の規定のいずれかを満たしておらず、かつ、満たしていないことについて正当な理由がないと甲が認める場合において、甲から請求を受けたときは当該知的財産権を無償で甲に譲り渡さなければならない。

（知的財産権の報告）

第3条 前条に関して、乙は、本契約に係る産業財産権等の出願又は申請を行うときは、出願又は申請に際して提出すべき書類の写しを添えて、あらかじめ甲にその旨を通知しなければならない。

- 2 乙は、産業技術力強化法（平成12年法律第44号）第17条第1項に規定する特定研

究開発等成果に該当するもので、かつ、前項に係る国内の特許出願、実用新案登録出願、意匠登録出願を行う場合は、特許法施行規則（昭和35年通商産業省令第10号）、実用新案法施行規則（昭和35年通商産業省令第11号）及び意匠法施行規則（昭和35年通商産業省令第12号）等を参考にし、当該出願書類に国の委託事業に係る研究の成果による出願である旨を表示しなければならない。

- 3 乙は、第1項に係る産業財産権等の出願又は申請に関して設定の登録等を受けた場合には、設定の登録等の日から60日以内（ただし、外国にて設定の登録等を受けた場合は90日以内）に、甲にその旨書面により通知しなければならない。
- 4 乙は、本契約に係る産業財産権等を自ら実施したとき及び第三者にその実施を許諾したとき（ただし、第5条第4項に規定する場合を除く。）は、実施等した日から60日以内（ただし、外国にて実施等をした場合は90日以内）に、甲にその旨書面により通知しなければならない。
- 5 乙は、本契約に係る産業財産権等以外の知的財産権について、甲の求めに応じて、自己による実施及び第三者への実施許諾の状況を書面により甲に報告しなければならない。

（乙が単独で行った発明等の知的財産権の移転）

第4条 乙は、本契約に関して乙が単独で行った発明等に係る知的財産権を第三者に移転する場合（本契約の成果を刊行物として発表するために、当該刊行物を出版する者に著作権を移転する場合を除く。）には、第2条から第6条まで及び第12条の規定の適用に支障を与えないよう当該第三者に約させなければならない。

- 2 乙は、前項の移転を行う場合には、当該移転を行う前に、甲にその旨書面により通知し、あらかじめ甲の承認を受けなければならない。ただし、乙の合併又は分割により移転する場合及び第2条第1項第4号イからハまでに定める場合には、この限りでない。
- 3 乙は、第1項に規定する第三者が乙の子会社又は親会社（これらの会社が日本国外に存する場合に限る。）である場合には、同項の移転を行う前に、甲に事前連絡の上、必要に応じて甲乙間で調整を行うものとする。
- 4 乙は、第1項の移転を行ったときは、移転を行った日から60日以内（ただし、外国にて移転を行った場合は90日以内）に、甲にその旨書面により通知しなければならない。
- 5 乙が第1項の移転を行ったときは、当該知的財産権の移転を受けた者は、当該知的財産権について、第2条第1項各号及び第3項並びに第3条から第6条まで及び第12条の規定を遵守するものとする。

（乙が単独で行った発明等の知的財産権の実施許諾）

第5条 乙は、本契約に関して乙が単独で行った発明等に係る知的財産権について第三者に実施を許諾する場合には、第2条、本条及び第12条の規定の適用に支障を与えないよう当該第三者に約させなければならない。

- 2 乙は、本契約に関して乙が単独で行った発明等に係る知的財産権に関し、第三者に専用実施権等の設定等を行う場合には、当該設定等を行う前に、甲にその旨書面により通知し、あらかじめ甲の書面による承認を受けなければならない。ただし、乙の合併又は分割により移転する場合及び第2条第1項第4号イからハまでに定める場合は、この限りではない。
- 3 乙は、前項の第三者が乙の子会社又は親会社（これらの会社が日本国外に存する場合に限る。）である場合には、同項の専用実施権等の設定等を行う前に、甲に事前連絡のうえ、必要に応じて甲乙間で調整を行うものとする。
- 4 乙は、第2項の専用実施権等の設定等を行ったときは、設定等を行った日から60日以内（ただし、外国にて設定等を行った場合は90日以内）に、甲にその旨書面により通知しなければならない。
- 5 甲は、本契約に関して乙が単独で行った発明等に係る知的財産権を無償で自ら試験又は研究のために実施することができる。甲が 甲のために第三者に製作させ、又は業務を代行する第三者に再実施権を許諾する場合は、乙の承諾を得た上で許諾するものとし、その実施条件等は甲乙協議のうえ決定する。

（乙が単独で行った発明等の知的財産権の放棄）

第6条 乙は、本契約に関して乙が単独で行った発明等に係る知的財産権を放棄する場合は、当該放棄を行う前に、甲にその旨書面により通知しなければならない。

（甲及び乙が共同で行った発明等の知的財産権の帰属）

第7条 甲及び乙は、本契約に関して甲乙共同で発明等を行ったときは、当該発明等に係る知的財産権について共同出願契約を締結し、甲乙共同で出願又は申請するものとし、当該知的財産権は甲及び乙の共有とする。ただし、乙は、次の各号のいずれの規定も遵守することを書面にて甲に届け出なければならない。

- 一 乙は、甲が国の要請に基づき公共の利益のために特に必要があるとしてその理由を明らかにして求める場合には、無償で当該知的財産権を実施する権利を国に許諾する。
- 二 乙は、当該知的財産権を相当期間活用していないと認められ、かつ、当該知的財産権を相当期間活用していないことについて正当な理由が認められない場合において、甲が国の要請に基づき当該知的財産権の活用を促進するために特に必要があるとしてその理由を明らかにして求めるときは、当該知的財産権を実施する権利を甲が指定する 第三者に許諾する。
- 2 前項の場合、出願又は申請のための費用は原則として、甲、乙の持分に比例して負担するものとする。
- 3 乙は、第1項に規定する書面を提出したにもかかわらず、同項各号の規定のいずれかを満たしておらず、さらに満たしていないことについて正当な理由がないと甲が認める場合において、甲から請求を受けたときは当該知的財産権のうち乙が所有する部分が無償で甲に譲り渡さなければならない。

(甲及び乙が共同で行った発明等の知的財産権の移転)

第8条 甲及び乙は、本契約に関して甲乙共同で行った発明等に係る共有の知的財産権のうち、自らが所有する部分を相手方以外の第三者に移転する場合には、当該移転を行う前に、その旨を相手方に書面により通知し、あらかじめ相手方の書面による同意を得なければならない。

(甲及び乙が共同で行った発明等の知的財産権の実施許諾)

第9条 甲及び乙は、本契約に関して甲乙共同で行った発明等に係る共有の知的財産権について第三者に実施を許諾する場合には、その許諾の前に相手方に書面によりその旨通知し、あらかじめ相手方の書面による同意を得なければならない。

(甲及び乙が共同で行った発明等の知的財産権の実施)

第10条 甲は、本契約に関して乙と共同で行った発明等に係る共有の知的財産権を試験又は研究以外の目的に実施しないものとする。ただし、甲は甲のために第三者に製作させ、又は業務を代行する第三者に実施許諾する場合は、無償にて当該第三者に実施許諾することができるものとする。

2 乙が本契約に関して甲と共同で行った発明等に係る共有の知的財産権について自ら商業的实施をするときは、甲が自ら商業的实施をしないことに鑑み、乙の商業的实施の計画を勘案し、事前に実施料等について甲乙協議の上、別途実施契約を締結するものとする。

(甲及び乙が共同で行った発明等の知的財産権の放棄)

第11条 甲及び乙は、本契約に関して甲乙共同で行った発明等に係る共有の知的財産権を放棄する場合は、当該放棄を行う前に、その旨を相手方に書面により通知し、あらかじめ相手方の書面による同意を得なければならない。

(著作権の帰属)

第12条 第2条第1項及び第7条第1項の規定にかかわらず、本契約の目的として作成され納入される著作物に係る著作権については、全て甲に帰属する。

2 乙は、前項に基づく甲及び甲が指定する 第三者による実施について、著作者人格権を行使しないものとする。また、乙は、当該著作物の著作者が乙以外の者であるときは、当該著作者が著作者人格権を行使しないように必要な措置を執るものとする。

3 乙は、本契約によって生じた著作物及びその二次的著作物の公表に際し、本契約による成果である旨を明示するものとする。

(合併等又は買収の場合の報告等)

第13条 乙は、合併若しくは分割し、又は第三者の子会社となった場合(乙の親会社に変更した場合を含む。第3項第1号において同じ。)は、甲に対しその旨速やかに報告し

なければならない。

2 前項の場合において、国の要請に基づき、国民経済の健全な発展に資する観点に照らし、本契約の成果が事業活動において効率的に活用されないおそれがあると甲が判断したときは、乙は、本契約に係る知的財産権を実施する権利を甲が指定する者に許諾しなければならない。

3 乙は、本契約に係る知的財産権を第三者に移転する場合、次の各号のいずれの規定も遵守することを当該移転先に約させなければならない。

一 合併若しくは分割し、又は第三者の子会社となった場合は、甲に対しその旨速やかに報告する。

二 前号の場合において、国の要請に基づき、国民経済の健全な発展に資する観点に照らし本業務の成果が事業活動において効率的に活用されないおそれがあると甲が判断したときは、本契約に係る知的財産権を実施する権利を甲が指定する者に許諾する。

三 移転を受けた知的財産権をさらに第三者に移転するときは、本項各号のいずれの規定も遵守することを当該移転先に約させる。

（秘密の保持）

第14条 甲及び乙は、第2条及び第7条の発明等の内容を出願公開等により内容が公開される日まで他に漏えいしてはならない。ただし、あらかじめ書面により出願又は申請を行った者の了解を得た場合はこの限りではない。

（委任・下請負）

第15条 乙は、本契約の全部又は一部を第三者に委任し、又は請け負わせた場合においては、当該第三者に対して、本特約条項の各規定を準用するものとし、乙はこのために必要な措置を講じなければならない。

2 乙は、前項の当該第三者が本特約条項に定める事項に違反した場合には、甲に対し全ての責任を負うものとする。

（協議）

第16条 第2条及び第7条の場合において、単独若しくは共同の区別又は共同の範囲等について疑義が生じたときは、甲乙協議して定めるものとする。

（有効期間）

第17条 本特約条項の有効期限は、本契約の締結の日から当該知的財産権の消滅する日までとする。

以上

別添－４

イーター実施協定の調達に係る情報及び知的財産に関する特約条項

本契約については、本契約一般条項によるほか、次の特約条項（以下「本特約条項」という。）による。

（定義）

第１条 本契約において「知的財産権」とは、次の各号に掲げるものをいう。

- （１） 特許法（昭和３４年法律第１２１号）に規定する特許権又は特許を受ける権利
- （２） 実用新案法（昭和３４年法律第１２３号）に規定する実用新案権又は実用新案登録を受ける権利
- （３） 意匠法（昭和３４年法律第１２５号）に規定する意匠権又は意匠登録を受ける権利
- （４） 商標法（昭和３４年法律第１２７号）に規定する商標権又は商標登録を受ける権利
- （５） 半導体集積回路の回路配置に関する法律（昭和６０年法律第４３号）に規定する回路配置利用権又は回路配置利用権の設定の登録を受ける権利
- （６） 種苗法（平成１０年法律第８３号）に規定する育成者権又は品種登録を受ける地位
- （７） 著作権法（昭和４５年法律第４８号）に規定するプログラムの著作物及びデータベースの著作物の著作権
- （８） 外国における、第１号から第７号に記載の各知的財産権に相当する権利
- （９） 不正競争防止法（平成５年法律第４７号）に規定する営業秘密に関して法令により定められた権利又は法律上保護される利益に係る権利（以下「営業秘密」という。）

２ 本契約において「情報」とは、法律による保護を受けることができるか否かを問わず、発明や発見の記述のみならず、公表されている資料、図書、意匠、計算書、報告書その他の文書、研究開発に関する記録された資料又は方法並びに発明及び発見に関する説明であって、前項に定義する知的財産権を除いたものをいう。

３ 本契約において「発明等」とは、特許権の対象となるものについては発明、実用新案権の対象となるものについては考案、意匠権、商標権、回路配置利用権及びプログラム等の著作権の対象となるものについては創作、育成者権の対象となるものについては育成並びに営業秘密を使用する権利の対象となるものについては案出をいう。

４ 本契約において「背景的な知的財産権」とは、本契約の締結前に取得され、開発され、若しくは創出された知的財産権又は本契約の範囲外において取得され、開発され、若しくは創出される知的財産権をいう。

５ 本契約において「背景的な営業秘密」とは、背景的な知的財産権のうちの営業秘密をいう。

６ 本契約において「生み出された知的財産権」とは、本契約の履行の過程で、乙が単独で又は甲と共同で取得し、開発し、又は創出した知的財産権をいう。

７ 本契約において「協定」とは、「イーター事業の共同による実施のためのイーター国際核融合エネルギー機構の設立に関する協定」をいう。

８ 本契約において「附属書」とは、協定の「情報及び知的財産に関する附属書」をいう。

９ 本契約において「イーター機構」とは、協定により設立された「イーター国際核融合エネルギー機構」をいう。

１０ 本契約において「加盟者」とは、協定の締約者をいう。

１１ 本契約において「国内機関」とは、各加盟者がイーター機構への貢献を行うに当たって、

その実施機関として指定する法人をいう。

1 2 本契約において「団体」とは、国内機関又はイーター機構が協定の目的のために物品又は役務の提供に関する契約を締結する団体をいう。

1 3 本契約において「理事会」とは、協定第6条に定める「理事会」をいう。

1 4 本契約において「特許等」とは、特許、登録実用新案、登録意匠、登録商標、登録回路配置及び登録品種の総称をいう。

(情報の普及)

第2条 乙は、加盟者又は国内機関が、本契約の実施により直接に生じる情報（著作権の有無を問わない。）を非商業上の利用のため翻訳し、複製し、及び公に頒布する権利を有することに同意する。

2 乙は、前項により作成される著作権のある著作物の写しであって公に頒布されるすべてのものには、著作者が明示的に記名を拒否しない限り、著作者の氏名を明示することに同意する。

(発明等の報告)

第3条 乙は、本契約の履行の過程で発明等を創出した場合には（以下、かかる発明等を「本発明等」という。）、本発明の詳細とともに、速やかに甲に書面により報告するものとする。

2 乙は、甲が前項の本発明の詳細を含む報告をイーター機構及び加盟者に提供すること、並びに、甲が自ら実施する核融合の研究開発に関する活動のため必要とする場合において乙以外の日本の団体に提供することに、あらかじめ同意する。

(生み出された知的財産権の帰属等)

第4条 本発明等に係る知的財産権は、乙に帰属する。ただし、本発明等が甲乙共同で創出したものである場合、当該本発明等に係る知的財産権は甲及び乙の共有となる。

2 前項ただし書きの甲及び乙の共有に係る知的財産権について、甲及び乙は、知的財産権の持分、費用分担、その他必要な事項を協議の上、別途取決めを締結するものとする。

3 乙は、甲及び乙の共有に係る当該知的財産権を自ら又は乙が指定する者が実施する場合、甲及び乙の持分に応じてあらかじめ定める不実施補償料を甲に支払うものとする。

(発明等の取扱い)

第5条 乙は、本発明等に関し、(i)特許等の登録に必要な手続を行うか、(ii)営業秘密として管理するか、又は、(iii)(i)若しくは(ii)のいずれも行わないかという取扱いについて速やかに決定の上、甲に決定内容を書面により報告する。ただし、当該本発明等が甲乙共同で創出したものである場合、甲及び乙は、上記(i)ないし(iii)の取扱いについて別途協議の上決定する。

2 乙は、前項に基づく本発明等の取扱いに関する決定内容について、甲がイーター機構及び加盟者に提供すること、並びに甲が自ら実施する核融合の研究開発に関する活動のため必要とする場合において乙以外の日本の団体に提供することに、あらかじめ同意する。

3 乙は、乙が第1項の(iii)の取扱いをすることを決定した本発明等について、甲又はイーター機構の求めがあった場合は、当該本発明等の知的財産権を甲又はイーター機構に承継させるものとする。

（背景的な知的財産権の認定）

第6条 乙が本契約の履行の過程で利用する背景的な知的財産権は、甲及び乙が別途締結する覚書（以下「覚書」という。）に定める。覚書に定めのない知的財産権であって、本契約の履行の過程で利用されるものは、生み出された知的財産権とみなす。

2 乙は、覚書に掲げる知的財産権の内容に変更が生じたときは、速やかに当該変更内容を甲に書面により報告するものとする。

3 乙は、本契約締結後に本契約の履行の過程で利用すべき背景的な知的財産権の存在が判明したときは、速やかに、当該背景的な知的財産権が、本契約の範囲外において存在することを証明する具体的な証拠とともに、本契約締結前に報告できなかった正当な理由を甲に書面により報告するものとする。

4 甲は、前項の報告を受けた場合は、乙から提出された証拠及び理由の妥当性を検討の上、必要に応じて、甲乙協議の上、覚書の改訂を行うものとする。

5 乙は、本条に基づく報告について、甲がイーター機構及び加盟者に提供すること、並びに甲が自ら実施する核融合の研究開発に関する活動のため必要とする場合において乙以外の日本の団体に提供することに、あらかじめ同意する。

6 乙は、本契約の履行の過程で背景的な知的財産権を利用する場合は、必要な実施権又は利用権を確保し、甲並びに契約物品の提供を受けるイーター機構及び関連する他の加盟者が、支障なく当該物品を使用することができるようにしなければならない。甲並びにイーター機構及び関連する他の加盟者が当該背景的な知的財産権に関し、第三者から知的財産権侵害の苦情を受けた場合には、乙は自己の責任と費用でその苦情を防御又は解決し、当該苦情に起因する損失、損害又は経費のすべてを補償し、甲並びにイーター機構及び関連する他の加盟者に対して何らの損害も与えないものとする。

（背景的な知的財産権の帰属）

第7条 本契約は、背景的な知的財産権の帰属について何ら変更を生じさせるものではない。

（創出者への補償等）

第8条 乙は、乙の従業者又は役員（以下「従業者等」という。）が創出した本発明等に係る知的財産権を、適用法令に従い、乙の費用と責任において従業者等から承継するものとする。

（生み出された知的財産権の実施）

第9条 生み出された知的財産権の実施権の許諾（利用権の付与を含む。以下同じ。）については、次の各号による。

（1） 乙は、甲が自ら実施する研究開発に関する活動のために、平等及び無差別の原則に基づき、当該生み出された知的財産権の取消し不能な、非排他的な、かつ、無償の実施権を甲に許諾する。当該実施権は、甲が第三者に再実施を許諾する権利を伴う。

（2） 乙は、公的な支援を得た核融合の研究開発に関する計画のため、平等及び無差別の原則に基づき、当該生み出された知的財産権の取消し不能な、非排他的な、かつ、無償の実施権を加盟者及びイーター機構に許諾する。当該実施権は、イーター機構及び加盟者が第三

者（加盟者については、それぞれの領域内の第三者に限る。）に再実施を許諾する権利を伴う。

（３） 乙は、核融合の商業上の利用のため、平等及び無差別の原則に基づき、生み出された知的財産権の非排他的な実施権を加盟者に許諾する。当該実施権は、加盟者が第三者（それぞれの領域内の第三者に限る。）に再実施を許諾する権利を伴う。当該実施権の許諾に係る条件は、乙が第三者に対して当該生み出された知的財産権の実施権を許諾するときの条件よりも不利でないものとする。

（４） 乙は、生み出された知的財産権の核融合以外の分野における利用を可能にするため、加盟者、国内機関、団体及び第三者と商業上の取決めを締結することが奨励される。

２ 前項の生み出された知的財産権が甲と乙の共有に係るものである場合、甲と乙は、共同して同項に基づく実施権の許諾を行う。

３ 乙は、第１項に規定する実施権及び再実施を許諾する権利の許諾の記録を保持し、甲の求めに応じこれを甲に提供する。乙は、上記記録に変更がある場合は、各年の上半期については、７月１５日までに、下半期については翌年の１月１５日までに甲に報告書を提出する。

４ 乙は、甲が当該記録をイーター機構及び加盟者に提供すること、並びに甲が自ら実施する核融合の研究開発に関する活動のため必要とする場合において乙以外の日本の団体に提供することに、あらかじめ同意する。

５ 乙は、非加盟者の第三者に対し、生み出された知的財産権の実施権を許諾する場合には、理事会が全会一致で決定する規則に従うものとし、甲の事前の同意を得て行うものとする。当該第三者への実施権の許諾は、平和的目的のための使用に限り行うものとする。ただし、当該規則の決定までは、非加盟者の第三者に対する当該実施権の許諾は認めない。

６ 乙は、イーター機構又は加盟者に対して直接実施許諾できない理由があるときには、甲が第１項第２号及び第３号に基づきイーター機構又は加盟者に再実施を許諾するための権利を伴う、生み出された知的財産権の取消し不能な、非排他的な、かつ、無償の実施権を甲に許諾するものとする。

（背景的な知的財産権の実施）

第１０条 乙が契約物品その他仕様書に定める納入品に用いる背景的な知的財産権の実施権の許諾については、次の各号による。

（１） 乙は、当該背景的な知的財産権（ただし、背景的な営業秘密を含まない。）が次のいずれかの要件を満たすときは、甲が自ら実施する核融合の研究開発に関する活動のために、平等及び無差別の原則に基づき、当該背景的な知的財産権の取消し不能な、非排他的な、かつ、無償の実施権を甲に許諾する。当該実施権は、甲が研究機関及び高等教育機関に再実施を許諾する権利を伴う。

イ イーター施設を建設し、運転し、及び利用するために必要とされること又はイーター施設に関連する研究開発のための技術を用いるために必要とされること。

ロ イーター機構に提供される契約物品を保守し、又は修理するために必要とされること。

ハ 公的な調達に先立ち理事会が必要であると決定する場合において必要とされること。

（２） 乙は、当該背景的な知的財産権（ただし、背景的な営業秘密を含まない。）が次のいず

れかの要件を満たすときは、公的な支援を得た核融合の研究開発に関する計画のため、平等及び無差別の原則に基づき、当該背景的な知的財産権の取消し不能な、非排他的な、かつ、無償の実施権を加盟者及びイーター機構に許諾する。当該実施権は、イーター機構が再実施を許諾する権利並びに加盟者がそれぞれの領域内において研究機関及び高等教育機関に再実施を許諾する権利を伴う。

イ イーター施設を建設し、運転し、及び利用するために必要とされること又はイーター施設に関連する研究開発のための技術を用いるために必要とされること。

ロ イーター機構に提供される契約物品を保守し、又は修理するために必要とされること。

ハ 公的な調達に先立ち理事会が必要であると決定する場合において必要とされること。

- (3) 乙は、当該背景的な営業秘密が次のいずれかの要件を満たすときは、当該背景的な営業秘密（イーター施設の建設、運転、保守及び修理のための手引書又は訓練用教材を含む。）の取消し不能な、非排他的な、かつ、無償の利用権をイーター機構に付与する。当該利用権は、イーター機構が、協定の情報及び知的財産に関する附属書第4、2、3条（b）に基づき、その下請負人に再利用権を付与する権利及びフランス規制当局に当該背景的な営業秘密を伝達する権利を伴う。

イ イーター施設を建設し、運転し、及び利用するために必要とされること又はイーター施設に関連する研究開発のための技術を用いるために必要とされること。

ロ イーター機構に提供される契約物品を保守し、又は修理するために必要とされること。

ハ 公的な調達に先立ち理事会が必要であると決定する場合において必要とされること。

ニ イーター施設に対して規制当局が要請する安全、品質保証及び品質管理のために必要とされること。

- (4) 乙は、当該背景的な営業秘密が次のいずれかの要件を満たすときは、加盟者が公的な支援を得た核融合の研究開発に関する計画のため、金銭上の補償を伴う私的契約によって、当該背景的な営業秘密の商業上の利用権の付与又は当該背景的な営業秘密を用いた契約物品と同一の物品の提供を求めた場合には、当該契約締結のため最善の努力を払うこととする。当該利用権の付与又は物品の提供に係る条件は、乙が第三者に対して当該背景的な営業秘密の利用権を付与し、又は当該背景的な営業秘密を用いた同一の物品を提供するときの条件よりも不利でないものとする。当該利用権が付与される場合には、当該利用権は、利用権者が契約上の義務を履行しない場合にのみ取り消すことができる。

イ イーター施設を建設し、運転し、及び利用するために必要とされること又はイーター施設に関連する研究開発のための技術を用いるために必要とされること。

ロ イーター機構に提供される契約物品を保守し、又は修理するために必要とされること。

ハ 公的な調達に先立ち理事会が必要であると決定する場合において必要とされること。

- (5) 乙は、当該背景的な知的財産権について、加盟者が核融合の商業上の利用のため、当該背景的な知的財産権の実施権の許諾を受けること又は当該背景的な知的財産権を用いた契約物品と同一の物品の提供を求めた場合には、当該要求の実現のため最善の努力を払うこととする。当該背景的な知的財産権の実施権は、当該加盟者の領域内にある第三者による核融合の商業上の利用のために当該加盟者が再実施を許諾する権利を伴う。当該背景的な知的財産権の実施権の許諾に係る条件は、乙が第三者に対して当該背景的な知的財産権の実施権を

許諾するときの条件よりも不利でないものとする。当該背景的な知的財産権の実施権は、実施権者が契約上の義務を履行しない場合にのみ取り消すことができる。

- (6) 乙は、前号に定める目的以外の商業上の目的のため、加盟者から求めがあった場合は、当該背景的な知的財産権が次のいずれかの要件を満たすときは、当該背景的な知的財産権の実施権を許諾することが奨励される。乙が、当該背景的な知的財産権の実施権を当該加盟者に許諾する場合には、当該背景的な知的財産権の実施権は平等及び無差別の原則に基づき許諾されるものとする。

イ イーター施設を建設し、運転し、及び利用するために必要とされること又はイーター施設に関連する研究開発のための技術を用いるために必要とされること。

ロ イーター機構の提供される契約物品を保守し、又は修理するために必要とされること。

ハ 公的な調達に先立ち理事会が必要であると決定する場合において必要とされること。

- 2 前項の背景的な知的財産権が甲と乙の共有に係るものである場合、甲と乙は、共同して当該背景的な知的財産権の実施権の許諾を行う。
- 3 乙は、第1項に規定する実施権及び再実施を許諾する権利の許諾の記録を保持し、甲の求めに応じこれを甲に提供する。乙は、上記記録に変更がある場合は、各年の上半期については7月15日までに、下半期については翌年の1月15日までに甲に報告書を提出する。
- 4 乙は、甲が当該記録をイーター機構及び加盟者に提供すること、並びに甲が自ら実施する核融合の研究開発に関する活動のため必要とする場合において乙以外の日本の団体に提供することに、あらかじめ同意する。

(知的財産権の帰属の例外)

第11条 乙は、本契約の目的として作成される提出書類、プログラム及びデータベース等の納入品に係る著作権は、すべて甲に帰属することを認め、乙が著作権を有する場合（第8条に基づき従業者等から承継する場合を含む。）であっても、乙は、かかる著作権（著作権法第21条から第28条までに定める全ての権利を含み、日本国内における権利に限らない。）を甲に譲渡する。かかる譲渡の対価は、本契約書に定める請負の対価に含まれる。

- 2 前項の規定により著作権を乙から甲に譲渡する場合において、当該著作物を乙が自ら創作したときは、乙は、著作者人格権を行使しないものとし、当該著作物を乙以外の第三者が創作したときは、乙は、当該第三者に著作者人格権を行使しないように必要な措置を講じるものとする。

(下請負人に対する責任)

第12条 乙は、本契約一般条項の規定に従い、下請負人に対し本契約の一部を履行させる場合、本特約条項に基づく乙の一切の義務を乙の責任において当該下請負人に遵守させるものとする。

(有効期間)

第13条 本契約一般条項の定めにかかわらず、本特約条項の定めは協定の終了後又は日本国政府の協定からの脱退後も効力を有する。

(言語)

第14条 本特約条項に定める乙から甲への書面による報告は、和文だけでなく、英文でも提出することとし、両文書は等しく正文とする。

(疑義)

第15条 本特約条項の解釈又は適用に関して疑義が生じた場合、協定の規定が本特約条項に優先する。

イーター調達に係る貨物の免税輸入について

イーター事業の共同による実施のためのイーター国際核融合エネルギー機構の特権及び免除に関する協定（イーター協定）に基づき、イーターに係る貨物の日本国内機関(JADA)及びメーカー・商社による輸入関税及び引取りに係る内国消費税の免税輸入を可能とする例外的な措置について、以下の要件等を遵守することで免税法令の適用対象となることが出来ます。

1. 免税適用のための要件

(1) 免税適用となる貨物

- ・イーター活動（R&D 及びクオリフィケーションを含む）のためだけに使用される物品を適用対象とする。
- ・この内、完成品（本契約における納入品を言う）のみを適用対象とする。
- ・ただし、8割方以上完成している物品については、ほぼ完成品の輸入とみなし、適用対象とする。

(2) 免税適用とならない貨物

- ・原材料及び資機材、並びに製作治具等。
- ・本契約締結日より前に輸入した物品。
- ・上記(1)に該当する物品と該当しない物品とが混在して輸入され、別個に通関申告が出来ない場合。

疑義が生じる場合には、輸入前にQST担当者と別途協議するものとする。

2. 必要な手続き

- (1) 1. (1)に該当する貨物を輸入する際には、輸入手続きを開始する前に必ずQSTの契約担当者に申し出ること。免税適用に疑義がある場合も同様とする。
- (2) 受注者は、輸入申告前に原子力機構から発行される「確認書」の正本を受領し、輸入通関書類と併せて申告すること。

3. 契約に係る注意事項

- ・免税輸入通関のためには、通関申告前に、QSTから通関を予定している税関に連絡する必要がある。（その際、輸入通関書類及び「確認書」（写し）の提出をしている）。
- ・契約に際しては、免税を加味しない金額で契約を実施するが、免税が適用された場合には、免税相当額を減額して支払うこととし、事前に書面をもって確認する。

- ・ 免税適用可否については、通関する担当税関が最終判断を担うが、(1)にて免税適用となりうる貨物に関しては、免税となるよう誠意をもってQST担当者と協力すること。

2. 免税適用法令一抜粋（参考）

(1) 関税定率法（外交官用貨物等の免税）

第十六条 左の各号に掲げる貨物で輸入されるものについては、政令で定めるところにより、その関税を免除する。

- 一 本邦にある外国の大使館、公使館その他これらに準ずる機関に属する公用品。但し、外国にある本邦のこれらの機関に属する公用品についての関税の免除に制限を附する国については、相互条件による。

(2) 輸入品に対する内国消費税の徴収等に関する法律（免税等）

第十三条 次の各号に掲げる課税物品で当該各号に規定する規定により関税が免除されるもの（関税が無税とされている物品については、当該物品に関税が課されるものとした場合にその関税が免除されるべきものを含む。第三項において同じ。）を保税地域から引き取る場合には、政令で定めるところにより、その引取りに係る消費税を免除する。

- 三 関税定率法第十六条第一項 各号（外交官用貨物等の免税）に掲げるもの

以上



IDM UID

2MLX45

VERSION CREATED ON / VERSION / STATUS

19 Mar 2010 / 1.1 / APPROVED

EXTERNAL REFERENCE

MQP Quality Plan**QP Template for suppliers and subcontractors**

This template is for suppliers and their subcontractors to produce a Quality Plan. This is recommended template for users, not mandatory.

<i>Approval Process</i>			
	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
<i>Author</i>	Park S.	19-Mar-2010:signed	IO/DG/SQS/QA
<i>CoAuthor</i>			
<i>Reviewers</i>			
<i>Approver</i>	Sands D.	19-Mar-2010:approved	IO/DG/SQS/QA
<i>Document Security: level 1 (IO unclassified)</i>			
<i>RO: Sands David</i>			
<i>Read Access</i>	AD: ITER, AD: External Collaborators, AD: Division - Quality Assurance, AD: ITER Management Assessor, project administrator, RO		

<i>Change Log</i>				
<i>Title (Uid)</i>	<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
QP Template for suppliers and subcontractors (2MLX45_v1_1)	v1.1	Approved	19 Mar 2010	At the section 7, wordings are changed from (proposed) suppliers or subcontractors to (proposed) suppliers and subcontractors specifying what work they will be performing.
QP Template for suppliers and subcontractors (2MLX45_v1_0)	v1.0	Signed	12 Feb 2010	



Template for Suppliers and subcontractors of a DA

QUALITY PLAN

Document Number:		Revision Number:	
ITER PP Number:		ITER PA Number:	
Title of Item:			
Name of DA:			
Supplier of the DA:			
Prepared by Supplier	Approved by Supplier	Approved by DA	ITER Acceptance
Position: Name & signature	Position: Name & signature	Position: Name & signature	Position: Name & Signature
Date:	Date:	Date:	Date:

<PP: Procurement Package, PA: Procurement Arrangement>

※ This is a recommended template for user's guiding to develop a Quality Plan.

1. Scope

[This section shall describe the scope of work to be covered by this Quality Plan]

2. Quality Management

2.1 Description of Quality Management System of the organization:

[Provide certifications of recognized Quality Standards and valid date of the certifications, if any]

2.2 Detailed the breakdown of responsibilities within the organization:

[Add the organization flow chart]

2.3 Identify the different (external) organizations involved:

[Add the relationship flow chart between different organizations]

2.4 Identify within the different organizations involved the key individuals responsible for:

*[Ensuring that the activities performed in connection with the particular contract are planned, implemented and controlled and their progress monitored,
Communicating requirements peculiar to the contract to all affected organizations,
Resolving problems that may arise at interfaces between the organisations involved]*

2.5 Identify any access restrictions of IO to the premise of the supplier or its subcontractors that may apply:

3. Contract Review

[Indicate how, when and by whom contract requirements are to be reviewed and the review recorded]

4. Documents

[Show how, when and by whom documents will be controlled, and what kinds of documents will be submitted to IO]

5. Design

*[Indicate, if an organization performs design activities for the contract;
how, when and by whom design will be controlled, including:*

- *when, how, and by whom the design process is to be carried out, controlled and documented,*
- *the arrangements for the review, verification and validation of design output conformity to design inputs requirements.*

Where applicable, indicate the extent to which the IO will be involved in design activities, such as participation in design reviews and design verification.

Reference applicable codes, standards and regulatory requirements.

A list the computer programs to be used and indicate how, when, and by whom they will be controlled.

Otherwise “not applicable”.]

6. Procurement

[Show how, when and by whom procurements will be controlled.

Any important Items or activities that are to be purchased or subcontracted.

(Proposed) suppliers or subcontractors specifying what work they will be performing.

Relevant Quality Assurance Requirements and the methods to be used to satisfy regulatory requirements, which apply to, purchased or subcontracted products.]

7. Identification and control of items

[Where traceability is a requirement or necessary for the adequate control of the work, define its scope and extent, including;

How affected items are to be identified?

How contractual and regulatory traceability requirements are identified and incorporated into working documents?

What records relating to such traceability are to be generated and how and by whom they are to be controlled?]

8. Manufacture

[Indicate how processes, manufacture, assembly, inspections and tests will be controlled.

Where appropriate, introduce or refer to:

Relevant documented procedures and work instructions.

The methods to be used to monitor and control processes.

Criteria for workmanship.

Use of special and qualified processes and associated personnel.

Tools, techniques and methods to be used.]

9. Inspection and testing

[Show how, when and by whom inspection and test would be controlled, including:.

Any inspection and test plan to be used, and how and by whom they are reviewed and approved.

How and by whom inspection and test reports are reviewed and approved?

Acceptance criteria to be applied.

Acceptance of purchased or subcontracted items.

Any specific requirements for the identification of inspections and tests status.

The extent to which the IO and (Agreed) Notified Bodies will be involved, such as witnessing inspection and test.]

10. Measuring and Test Equipment

[Indicate the control system to be used for measuring and test equipment specifically used in connection with the contract, including:

- Identification of such equipment,*
- Method of calibration,*
- Method of indicating and recording calibration status.]*

11. Handling, Storage, Packing, Shipping and Delivery

[Show how, when and by whom handling, storage, packing, shipping and delivery will be controlled:

- how contract requirements for handling, storage, packaging and shipping are to be met,*
- how the item will be delivered to the specified site in a manner that will ensure that its required characteristics are not degraded.]*

12. Records

[This section should indicate:

How records are to be controlled, including how legibility, storage and retrievability will be satisfied

What records are to be kept

What records are to be supplied to the IO, when and by what means

How and by whom the records are reviewed and approved prior to inclusion in the deliverables handed over to the IO

What form the records will take (such as paper, microfilm, tape, disc or other medium) and in what language the records will be provided.]

13. Deviation and Non-Conformities

[Indicate how, when and by whom deviations and non-conformities will be processed including those originating from suppliers and subcontractor.]

14. Training and Qualification

[Address any specific training requirement for personnel and how such training is accomplished and recorded.]

15. Statistical Techniques

[Where statistical techniques are relevant for establishing, controlling and verifying process capability and item characteristics, they should be indicated.]

16. Assessment

[Indicate how, when and by whom the implementation and effectiveness of the Quality Plan will be monitored.]

17. Reference and Others (If any)

[A list of documents referenced in this Quality Plan]

❖ **Italics in boxes are provided to give instructions and need to be deleted when completing the form with an actual information.**

[Note] Preparation, implementation and approval of a Quality Plan

1. Much of the generic documentation needed to prepare a Quality Plan will normally already exist as part of the performer's quality management documents and supporting procedures. The Quality Plan need only refer to this documentation and show how it is to be applied to the work contracted.
2. DAs shall prepare a Quality Plan and submit it to the IO for approval.
3. The DA Suppliers/Subcontractors Quality Plans are approved by the DA, and then submitted to the IO for acceptance.
4. Work shall not start until the relevant Quality Plan has been accepted by the IO.
5. Work shall be performed as directed in the Quality Plan. The performers (DAs, and their suppliers and subcontractors) shall monitor the implementation and effectiveness of the Quality Plan.
6. Documents referred to in the Quality Plan should be made available to the IO.



IDM UID

22MFG4

VERSION CREATED ON / VERSION / STATUS

27 Jan 2025 / 6.3 / Approved

EXTERNAL REFERENCE / VERSION

Technical Specifications (In-Cash Procurement)

Quality Requirements for IO Performers

The purpose of this document is to provide IO performers with quality management requirements based on the quality class of structures, systems, and components (SSC).

Table of Contents

1	PURPOSE	3
2	DEFINITIONS AND ACRONYMS	3
3	REFERENCES	4
4	REQUIREMENT TO DEFINE QUALITY CLASS (QC)	5
5	COMMON REQUIREMENTS FOR QC 1-4.....	5
5.1	QUALITY MANAGEMENT SYSTEM	5
5.2	COUNTERFEIT, FRAUDULENT OR SUSPECT ITEMS (CFSI).....	5
5.3	COMMERCIAL-OFF-THE-SHELF / COTS ITEMS	6
5.4	PROPAGATION OF REQUIREMENTS	6
6	COMMON REQUIREMENTS FOR QC 1-3.....	6
6.1	CONTRACT MANAGEMENT (COMMON QC 1-3)	6
6.1.1	<i>Responsible Officer</i>	6
6.1.2	<i>Quality plan (QP)</i>	6
6.1.3	<i>Management of nonconformities</i>	7
6.1.4	<i>Management of deviations</i>	7
6.1.5	<i>Risk management</i>	7
6.1.6	<i>Access to Performer's premises</i>	7
6.2	ENGINEERING (COMMON QC 1-3)	7
6.3	MANUFACTURING, ASSEMBLY AND INSTALLATION (COMMON QC 1-3).....	7
6.3.1	<i>Inspection and Test Plan (ITP)</i>	7
6.3.2	<i>Readiness Review (CRR)</i>	7
6.3.3	<i>Material certificates</i>	7
6.3.4	<i>Manufacturing</i>	7
6.4	IO ACCEPTANCE (COMMON QC 1-3).....	7
6.4.1	<i>Contractor release note (CRN)</i>	7
6.4.2	<i>Mechanical Completion Dossier (MCD)</i>	8
6.5	STORAGE AND SHIPPING (COMMON QC 1-3)	8
6.5.1	<i>Conditions to ship - CRN and shipping notification</i>	8
6.5.2	<i>Conditions to ship - Delivery Readiness Review (DRR)</i>	8
6.5.3	<i>Shipping</i>	8
7	SPECIFIC REQUIREMENTS FOR QC 1.....	8
7.1	ENGINEERING (EXTRAS FOR QC 1)	8
7.2	MANUFACTURING, ASSEMBLY AND INSTALLATION (EXTRAS FOR QC 1)	8
7.2.1	<i>Special processes</i>	8
7.2.2	<i>Preparation and change of inspection plan (IP, MIP/ITP)</i>	8
7.2.3	<i>Readiness review (CRR, MRR)</i>	9

7.2.4	<i>Execution of IP (MIP/ITP)</i>	9
7.2.5	<i>Manufacturing dossier</i>	9
7.3	STORAGE AND SHIPPING (EXTRAS FOR QC 1)	10
7.3.1	<i>Storage</i>	10
8	SPECIFIC REQUIREMENTS FOR PE/NPE	11
8.1	QUALIFICATION OF PERSONNEL (PE/NPE).....	11
8.2	ENGINEERING (EXTRAS FOR PE/NPE).....	11
8.3	MANUFACTURING (EXTRAS FOR PE/NPE)	11
8.3.1	<i>Special processes</i>	11
8.3.2	<i>Inspection plan</i>	11
8.4	STORAGE AND SHIPPING (EXTRAS FOR PE/NPE)	11
9	ANNEX 1. REQUIREMENTS AND GUIDANCE FOR THE CONTENT AND STRUCTURE OF QUALITY PLANS (QP)	12
9.1	CONTENT	12
9.2	STRUCTURE.....	12
9.2.1	<i>Quality Management</i>	12
9.2.2	<i>Contract Review</i>	13
9.2.3	<i>Document</i>	13
9.2.4	<i>Design</i>	13
9.2.5	<i>Procurement</i>	13
9.2.6	<i>Identification and Control of items</i>	13
9.2.7	<i>Manufacture</i>	14
9.2.8	<i>Inspection and Test</i>	14
9.2.9	<i>Measuring and Test equipment</i>	14
9.2.10	<i>Handling, Storage, Packing, Shipping and Delivery</i>	14
9.2.11	<i>Records</i>	14
9.2.12	<i>Deviations and Nonconformities</i>	15
9.2.13	<i>Training and Qualification</i>	15
9.2.14	<i>Statistical Techniques</i>	15
9.2.15	<i>Assessment</i>	15
10	ANNEX 2. REQUIREMENTS AND GUIDANCE FOR THE CONTENT OF INSPECTION PLANS (IP)	16
11	ANNEX 3. REQUIREMENTS AND GUIDANCE FOR THE CONTENT OF CONTRACTOR RELEASE NOTES (CRN)	17

1 Purpose

The purpose of this document is to provide IO performers with quality management requirements based on the quality class of structures, systems, and components (SSC).

2 Definitions and acronyms

Term	Acronym	Definition
(Agreed) Notified Body	(A)NB	Notified Body agreed by the French Nuclear Authority (ASN) to perform conformity assessment of Nuclear Pressure Equipment
Acceptance		Acknowledgement that a product or document is in compliance with the Contract requirements
Approval		Formal agreement for the use or application of a product or document. The approver takes responsibility for the use.
Certificate of Conformity	CoC	
Commercial-off-the-shelf (items), Commercial grade item or service	COTS	Item or service commercially available without modification.
Contract		PA, TA or contract
Contractor		An entity that have a contract with IO or DA
Contractor Release Note	CRN	A document to provide a confirmation from a Performer that the products supplied and/or services performed meet the requirements of Contract.
Construction Readiness Review	CRR	
Counterfeit item		Items that are intentionally manufactured, refurbished or altered to imitate original products without authorization in order to pass themselves off as genuine.
Counterfeit / fraudulent / suspect item	CFSI	
Critical quality activity		Any activity or operation that if not performed correctly may affect safety, functionality or reliability.
Domestic Agency	DA	An organization set up under the ITER Framework Agreement to provide goods or services to the IO through Procurement Arrangements (PA) and Task Agreements (TA).
Equipment	PE/NPE	Pressure Equipment or Nuclear Pressure Equipment
Fraudulent items		Items that are intentionally misrepresented with intent to deceive.
ITER Organization	IO	

Inspection Plan	IP	A plan used for the execution and control of Contract activities. It may also be referred to as a Manufacturing and Inspection Plan (MIP), Inspection and Test Plan (ITP), Control Plan (CP), or other similar terms.
Manufacturer		Any natural or legal person who manufactures an equipment or has an equipment designed or manufactured and markets under his name or trademark.
Mechanical Completion Dossier	MCD	
Manufacturing Database	MDB	
Manufacturing Readiness Review	MRR	
Notified Body	NB	Technical organisation approved in an EU state, either for approval and monitoring of the manufacturer's quality assurance system or for direct product inspection for the manufacture of Pressure Equipment.
Performer		An all-inclusive term used to cover DAs, contractors and subcontractors
Procurement Arrangement	PA	
Quality Class	QC	
Quality plan	QP	Document describing the operational quality system to ensure that Contract requirements will be met, and that evidence of such compliance will be maintained. It covers the whole scope of the Contract including work performed by contractors/subcontractors and addresses all activities performed in connection with the Contract.
Protection Important Component	PIC	As per INB Order (French Order of 07/02/2012)
Responsible Officer	RO	IO primary point of contact to manage a Contract.
Structures, systems and components	SSC	
Subcontractor		An entity that performs work for contractors
Suspect items		Items where there is an indication or suspicion that it may not be genuine.
Task Agreement	TA	

3 References

[1]	Quality Classification Determination (24VQES rev. 6.0 or consequent)
[2]	ITER Quality Assurance Program (QAP) (22K4QX)

[3]	Qualification of Protection Important Components (PIC) (XB5ABP)
[4]	Working Instruction for Processing Construction Nonconformities (U8VPSS)
[5]	Procedure for Management of Nonconformities (22F53X)
[6]	Procedure for the management of Deviation Request (2LZJHB)
[7]	Risk and Opportunity Management Procedure (22F4LE)
[8]	Work Instruction for producing an Inspection and Test Plan for construction (UELU9F)
[9]	Working Instruction for Construction Readiness Review (QXW4KQ)
[10]	Working Instruction for Completion Dossier Preparation (UYUSEE)
[11]	Working Instruction for the Delivery Readiness Review (DRR) (X3NEGB)
[12]	Procedure for Transportation of Components to ITER Site (RY5C6Q)
[13]	Procedure for the CAD management plan (2DWU2M)
[14]	Procedure for Analyses and Calculations (22MAL7)
[15]	Design Review Procedure (2832CF)
[16]	Working Instruction for Manufacturing Readiness Review (44SZYP)
[17]	Implementation plan for design & manufacture of PE/NPE (VE2DSP)
[18]	Inspection Plan (IP) Template (QV7GQF)
[19]	Construction Inspection and Test Plan Template (ITP) (TTPQL2)
[20]	Release Note Template (QVEKNQ)

4 Requirement to define quality class (QC)

The quality class of the SSC must be specified in the Contract.

The Performer may grade the SSC quality class specified in the Contract down to the component levels in accordance with reference [1].

The Performer shall inform the IO RO about any downgrade in the quality classification of components.

The Performer may request the IO RO to determine or change the quality class of SSC.

5 Common requirements for QC 1-4

5.1 Quality management system

The Performer shall establish and implement a quality system based on a recognized quality standard and shall meet the requirements outlined in reference [2].

This quality system shall be capable of ensuring that Contract requirements are met, and that evidence of such compliance is maintained.

In case of PA or TA, the Performer shall submit a description of the quality management system for the DA's acceptance. The DA shall forward the accepted description to the IO RO for information.

In the case of a direct contract with IO, the Performer shall submit a description of the quality management system for acceptance by the IO RO.

5.2 Counterfeit, Fraudulent or Suspect Items (CFSI)

The Performer shall prevent CFSI at all levels of operations including

- a) selection of subcontractors
- b) control of externally provided processes, products and services
- d) monitoring and measurement activities

When CFSI are detected, they shall be managed as nonconformities (6.1.3).

5.3 Commercial-off-the-shelf / COTS items

To procure and utilize COTS, controls through dedication method(s) shall be implemented to ensure that the item or service is adequate for its intended function. In particular, for PIC minimum requirements according to reference [3] shall be applied, including requested documentary traceability as applicable.

5.4 Propagation of requirements

The Performer shall ensure that the relevant requirements outlined in this document are communicated throughout their supply chain.

6 Common requirements for QC 1-3

6.1 Contract management (common QC 1-3)

6.1.1 Responsible Officer

The Performer shall appoint a Responsible Officer to:

- communicate with the IO
- coordinate the planning and performance of the work, including work assigned to subcontractors
- maintain time schedules and issue monthly progress reports
- verify that the quality systems are consistently followed during the execution of the Contract
- assess and oversee quality in subcontractor's premises
- monitor the implementation of IO requirements
- provide IO with periodic assessment of quality performance

6.1.2 Quality plan (QP)

The requirements and guidance for the content of QPs are provided in the Annex 1.

The Performer shall prepare a QP for all Contracts when all contractors and subcontractors are identified. Unless specified otherwise, for research and development activities not used for qualification purposes, only the DA (for TA) or the Contractor (for direct contracts) shall prepare a QP.

Subcontractors shall submit QPs to the Contractor for acceptance.

In the case of PA/TA, the Contractor shall submit its own QP and QPs of the subcontractors to the DA for acceptance, and the DA shall then submit all QPs for the IO RO's acceptance.

In the case of direct contract, the Contractor shall submit its own QP and QPs of the subcontractors to the IO RO for acceptance.

The Performer shall revise the QP if changes occur that require it and submit it for acceptance in the same manner as the original plan.

At the IO RO's request, the Performer shall provide the documents referenced in the QP.

The Performer shall carry out the activities in accordance with the QP accepted by IO RO.

6.1.3 Management of nonconformities

For work on the ITER construction site, the Performer shall manage nonconformities in accordance with reference [4].

Otherwise, the Performer shall manage nonconformities in accordance with reference [5].

6.1.4 Management of deviations

To deviate from Contract requirements the Performer shall initiate a deviation request and follow the process in accordance with reference [6].

6.1.5 Risk management

The Performer shall manage risks in accordance with reference [7].

6.1.6 Access to Performer's premises

The Performer shall ensure that the IO/DA representatives and representatives or regulatory bodies have access to the premises when required to oversee or support the work being executed.

6.2 Engineering (common QC 1-3)

The Performer shall have the design approved by design authorities established through controlled procedures.

The Performer shall submit the final design for the IO RO's acceptance.

6.3 Manufacturing, assembly and installation (common QC 1-3)

6.3.1 Inspection and Test Plan (ITP)

For work on the ITER construction site, the Performer shall plan and implement control measures using the Inspection and Test Plan (ITP) in accordance with reference [8].

6.3.2 Readiness Review (CRR)

For work on the ITER construction site, the Performer shall conduct a Construction Readiness Review (CRR) in accordance with reference [9].

6.3.3 Material certificates

The Performer shall submit material certificates to the IO RO for acceptance.

6.3.4 Manufacturing

If the design is included in the Performer's scope of work, the Performer shall not begin manufacturing until the final design has been accepted by the IO RO.

For work on the ITER construction site, the Performer shall treat the mechanical completion dossier (MCD) in accordance with reference [10].

6.4 IO Acceptance (common QC 1-3)

6.4.1 Contractor release note (CRN)

The requirements and guidance for the content of CRNs are provided in the Annex 3.

Prior to factory acceptance, or shipment, if there is no factory acceptance, of products and/or services, the Performer shall certify in the Contractor Release Note (CRN) that all required verifications, inspections, and tests are complete and satisfactory, and that all necessary documentation is available, and shall submit the CRN to the IO RO for acceptance.

6.4.2 Mechanical Completion Dossier (MCD)

For work on the ITER construction site, the Performer shall submit the MCD in accordance with reference [10].

6.5 Storage and shipping (common QC 1-3)

6.5.1 Conditions to ship - CRN and shipping notification

The Performer shall not ship the products prior to the acceptance of the CRN by the IO RO.

The Performer shall submit a shipping notification to the IO RO and shall not ship the products prior to their acceptance by the IO RO.

6.5.2 Conditions to ship - Delivery Readiness Review (DRR)

The Performer shall not ship the products until the Delivery Readiness Review (DRR) is completed in accordance with reference [11].

6.5.3 Shipping

The Performer shall ship the products in accordance with reference [12].

7 Specific requirements for QC 1

7.1 Engineering (extras for QC 1)

The Performer shall submit a request to use software and/or models for design and operations to the IO RO.

The Performer shall manage CAD works and data in accordance with the reference [13].

The Performer shall perform analyses and calculations in accordance with the reference [14].

The Performer shall conduct design reviews in accordance with the reference [15].

7.2 Manufacturing, assembly and installation (extras for QC 1)

7.2.1 Special processes

For special processes, the Performer shall submit qualification documents and records for the IO RO's acceptance.

7.2.2 Preparation and change of inspection plan (IP, MIP/ITP)

For work on the ITER construction site, the Performer plans control measures using the Inspection and Test Plan (ITP) in accordance with chapter 6.3.1 (reference [8]).

Otherwise, the Performer shall plan control measures using generic Inspection Plans (IP) as follows:
The requirements and guidance for the content of IPs are provided in the Annex 2.

When an (Agreed) Notified Body ((A)NB) is involved, the Performer shall submit the IP to the (A)NB before submitting it to DA or IO.

In the case of PA, the Performer shall submit the IP to the DA for marking intervention points. The DA shall then submit the IP to the IO RO for marking interventions and acceptance.

In case of IO direct contracts, the Performer shall directly submit the IP to the IO RO for marking intervention points and acceptance.

At the IO RO's request, the Performer shall provide the documents referenced in the IP.

The Performer may revise the IP if changes are required and shall submit it for acceptance in the same manner as the original plan, unless instructed otherwise in writing by IO RO.

7.2.3 Readiness review (CRR, MRR)

For work on the construction site, the Performer conducts a Construction Readiness Review (CRR) in accordance with chapter 6.3.2 (reference [9]).

Otherwise, the Performer shall conduct manufacturing readiness review (MRR) in accordance with the reference [16].

7.2.4 Execution of IP (MIP/ITP)

For work on the ITER construction site, the Performer implements control measures using the Inspection and Test Plan (ITP) in accordance with chapter 6.3.1 (reference [8]).

Otherwise, the Performer implements control measures using generic Inspection Plans (IP) as follows:
The Performer shall not begin executing activities until the IP is accepted by the IO RO and shall carry out the activities in accordance with the IP once it is accepted.

The Performer shall not begin executing activities until the MRR has been completed.

The Performer shall notify DA and IO of the intervention points before executing the relevant operations as defined in the IP.

The Performer shall ensure that the IP is readily accessible to those performing the work.

The Performer shall ensure that the IP is updated in a timely manner - each operation shall be recorded at least before the next concerned intervention point so that to allow tracking by IO and DAs of IP execution during operation's progress (e.g. by using MDB or other equivalent digitalized tools).

The Performer shall ensure that each operation is signed off and dated by the person in charge of the operation.

The Performer shall ensure that records associated with operations (inspection reports, test reports, nonconformity reports etc.) are properly referenced in the IP and made available by suitable means to the party responsible for the intervention.

The Performer shall ensure that each intervention point is signed off and dated by the person carrying out the intervention. IO Acceptance (extras for QC 1)

7.2.5 Manufacturing dossier

Prior to factory acceptance or shipment (in the absence of factory acceptance) of products, the Performer shall submit the manufacturing dossier to the IO RO.

7.3 Storage and shipping (extras for QC 1)

7.3.1 Storage

The Performer shall store the products in accordance with IO technical specifications provided by the IO RO.

8 Specific requirements for PE/NPE

8.1 Qualification of personnel (PE/NPE)

If IO is the Manufacturer of Equipment, the qualification of Performer's personnel shall be carried out in accordance with the requirements of the reference [17].

8.2 Engineering (extras for PE/NPE)

The Performer shall submit the final design for the IO RO's approval.

8.3 Manufacturing (extras for PE/NPE)

If the design is included in the Performer's scope of work, the Performer shall not begin manufacturing until the final design has been approved by the IO RO.

8.3.1 Special processes

If IO is the Manufacturer of Equipment, the qualification of special processes shall be carried out in accordance with the requirements of the reference [17].

8.3.2 Inspection plan

When IO acts as the manufacturer of Equipment under the scope of Module H, a specific column in the IP shall be dedicated to defining control points related to the implementation of Module H. The column labelled "Third Party" or "Other" in templates [18] or [19] may be used for this purpose.

8.4 Storage and shipping (extras for PE/NPE)

When IO acts as the Manufacturer of Equipment, the procedures related to handling, storage, or shipping shall be approved by the IO RO.

9 Annex 1. Requirements and guidance for the content and structure of Quality Plans (QP)

9.1 Content

Quality Plans shall be brief and to the point, while giving sufficient visibility on the control of the activities to be carried out.

The Quality Plan shall identify:

- the critical quality activities and associated controls
- the specific allocation of resources, duties, responsibilities and authority
- details of all contractors/subcontractors and how interfaces will be managed
- the specific procedures, methods and work instructions to be applied
- the specific methods of communication, both formal and informal, to be established between working groups

The level of detail in the plan shall be consistent with:

- the technical requirements of the Contract
- the safety and operational importance of the items involved
- the complexity of the organizations, functions and activities involved
- the degree of design innovation
- the involvement of innovative processes
- the involvement of processes which cannot be fully verified by inspection or test
- the degree to which functional compliance can be demonstrated by inspection or test
- design, performance or manufacturing margins

Much of the generic documentation needed to prepare the Quality Plan will normally already exist as part of the performer's quality documents and supporting procedures. The Quality Plan need only refer to this documentation and show how it is to be applied to the particular Contract.

The Quality Plan may be a single document that covers the whole scope of the Contract, including work performed by subcontractors. The plan may also be the compilation of coordinated separate and well-defined documents.

9.2 Structure

It is not essential for the Quality Plan to follow the structure outlined below which is given for guidance.

The elements listed in the following sections are neither prescriptive nor exhaustive and shall be addressed only where relevant:

9.2.1 Quality Management

The plan shall:

- identify all critical quality activities and associated controls
- identify the different organizations involved
- detail the breakdown of responsibilities
- identify within the different organizations involved the key individuals responsible for:

- ensuring that the activities performed in connection with the particular Contract are planned, implemented and controlled and their progress monitored
- communicating requirements peculiar to the specific Contract to all affected organizations
- resolving problems that may arise at interfaces between the organisations involved

An organization flow chart could facilitate the understanding.

9.2.2 Contract Review

The plan shall indicate how, when and by whom Contract requirements are to be reviewed and the review recorded.

9.2.3 Document

The plan shall show how, when and by whom documents will be controlled.

9.2.4 Design

The plan shall show how, when and by whom design will be controlled, including:

- when, how and by whom the design process is to be carried out, controlled and documented
- the arrangements for the review, verification and validation of design output conformity to design inputs requirements

Where applicable, the plan shall indicate the extent to which the IO will be involved in design activities, such as participation in design reviews and design verification.

The plan shall reference applicable codes, standards and regulatory requirements.

The plan shall:

- list the computer programs to be used
- indicate how, when and by whom they will be controlled

9.2.5 Procurement

The plan shall show how, when and by whom procurements will be controlled, including:

- any important items or activities that are to be purchased or subcontracted
- the relevant quality assurance requirements
- the proposed contractors or subcontractors
- the methods to be used to evaluate, select and control contractors and subcontractors
- the methods to be used to satisfy regulatory requirements, which apply to, purchased or subcontracted products

9.2.6 Identification and Control of items

Where traceability is a requirement or necessary for the adequate control of the work, the plan shall define its scope and extent, including:

- how affected items are to be identified
- how Contract and regulatory traceability requirements are identified and incorporated into working documents
- what records relating to such traceability are to be generated and how and by whom they are to be controlled

9.2.7 *Manufacture*

The plan shall indicate how processes, manufacture, assembly, inspections and tests will be controlled. Where appropriate, the plan shall introduce or refer to:

- relevant documented procedures and work instructions
- the methods to be used to monitor and control processes
- criteria for workmanship
- use of special and qualified processes and associated personnel
- tools, techniques and methods to be used

9.2.8 *Inspection and Test*

The plan shall show how, when and by whom inspection and test would be controlled, including:

- any inspection and test plan to be used, and how and by whom they are reviewed and approved
- how and by whom inspection and test reports are reviewed and approved
- acceptance criteria to be applied
- acceptance of purchased or subcontracted items
- any specific requirements for the identification of inspections and tests status
- the extent to which the IO and (Agreed) Notified Bodies will be involved, such as witnessing inspection and test

9.2.9 *Measuring and Test equipment*

The plan shall indicate the control system to be used for measuring and test equipment specifically used in connection with the particular Contract, including:

- identification of such equipment
- method of calibration
- method of indicating and recording calibration status

9.2.10 *Handling, Storage, Packing, Shipping and Delivery*

The plan shall show how, when and by whom handling, storage, packing, shipping and delivery will be controlled:

- how Contract requirements for handling, storage, packaging and shipping are to be met
- how the item will be delivered to the specified site in a manner that will ensure that its required characteristics are not degraded

9.2.11 *Records*

The plan shall indicate:

- how records are to be controlled, including how legibility, storage and retrievability will be satisfied
- what records are to be kept
- what records are to be supplied to the IO, when and by what means
- how and by whom the records are reviewed and approved prior to inclusion in the deliverables handed over to the IO
- what form the records will take (such as paper, microfilm, tape, disc or other medium) and in what language the records will be provided

9.2.12 Deviations and Nonconformities

The plan shall indicate how, when and by whom deviations and non-conformances will be processed including those originating from contractors and subcontractors.

9.2.13 Training and Qualification

The plan shall address:

- any specific training requirement for personnel
- how such training is accomplished and recorded

9.2.14 Statistical Techniques

Where statistical techniques are relevant for establishing, controlling and verifying process capability and item characteristics, they shall be indicated in the plan.

9.2.15 Assessment

The plan shall indicate how, when and by whom the implementation and effectiveness of the Quality Plan will be monitored.

10 Annex 2. Requirements and guidance for the content of Inspection Plans (IP)

An IP shall identify:

- Requirements and instructions applicable to those operations
- Operations to be inspected or witnessed by DA, IO and (Agreed) Notified Body ((A)NB).
- Documents providing traceability and recording of the verification and completion of these operations.

The level of detail in the IP shall be such as to prevent the inadvertent bypassing of quality activities and to enable adequate planning, monitoring and verification of operations.

The IP shall be written in English for IO and, if necessary, in Performer's working language to be easily understood by those carrying out the work.

The IP shall identify who is performing each intervention point.

A suggested format for the IP can be found at the IP template [18]. Alternative formats (including in electronic form) may be acceptable at discretion of IO RO in advance of their intended use.

11 Annex 3. Requirements and guidance for the content of Contractor Release Notes (CRN)

The Release Note shall be prepared using the Release Note template [20].

The Release Note shall:

- Certify that the product or service meets the Contract requirements
- List the documents and records constituting the manufacturing dossier and their status
- List any outstanding obligations

The list of documents and records below is non-exhaustive and shall be tailored to meet the Contract requirements.

1. Management Documents:
 - Quality Plan
 - List of contractors/subcontractors
2. Raw Materials - Metals, Ceramics and Other Materials
 - Procurement Specifications
 - Sub-Orders
 - Material Certification traceable to components
3. Manufacturing Documents
 - Fabrication Procedures (machining, forming, soldering, wiring)
 - Welding/Brazing Documents (WPS, PQR, WPQ etc...)
 - Weld Plan
 - Weld Inspection Record
 - Non-Destructive Examination Procedures (VT, PT, MT, RT, UT etc...)
 - Cleaning procedure
 - Surface Treatment Specification
4. Assembly and Test Documents
 - Assembly Sequences, Control Specifications and Procedures
 - Pressure Test Procedure
 - Helium Leak test procedure
 - Function Test Specifications
 - Control Reports (Visual Examination, Non-Destructive Examination, Electrical and
 - Insulation Tests, Leak Tests, Pressure Test, Certification of Cleanliness, etc.).
 - Deviation and Nonconformity Reports
 - Completed Manufacturing & Inspection Plan(s)
 - Drawings marked “As Built”



IDM UID

2EZ9UM

VERSION CREATED ON / VERSION / STATUS

28 May 2019 / 2.5 / Approved

EXTERNAL REFERENCE / VERSION

Guideline**ITER Vacuum Handbook**

ITER Vacuum Handbook.

Updated to include changes reviewed under scope of mPCR 260 Change Notice "PCR-M260 - Application of ITER Vacuum Handbook to standard products, clarification of requirements and minimal update to reflect the phase of the ITER project" for "ITER Vacuum Handbook (2EZ9UM v2.3)": review and approval (SK47R3 v1.0).

v2.5 is v2.3+ changes introduced through mPCR260. there is no change between v2.4 and v2.5.

<i>Approval Process</i>			
	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
<i>Author</i>	Worth L.	28 May 2019:signed	IO/DG/COO/PED/FCED/VS
<i>Co-Authors</i>			
<i>Reviewers</i>	Pearce R.	28 May 2019:recommended	IO/DG/COO/PED/FCED/VS
<i>Approver</i>	Lee G.- S.	28 May 2019:approved	IO/DG/COO
<i>Document Security: Internal Use</i> <i>RO: Chioecchio Stefano</i>			
<i>Read Access</i>	GG: MAC Members and Experts, GG: STAC Members & Experts, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: EMAB, AD: EUROfusion-DEMO, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: Section Scheduling, AD: OBS - Vacuum Section (VS) - EXT, AD: OBS - Vacuum ...		

<i>Change Log</i>			
ITER Vacuum Handbook (2EZ9UM)			
<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
v1.0	Signed	27 Aug 2008	
v1.1	Signed	28 Aug 2008	
v1.2	Signed	22 Oct 2008	
v1.3	Signed	27 Oct 2008	
v1.4	Signed	17 Dec 2008	
v2.0	Signed	10 Apr 2009	
v2.1	In Work	27 May 2009	
v2.2	Signed	28 May 2009	
v2.3	Approved	12 Jun 2009	VH ref. Original sentence V2.2 Modified sentence V2.3 7.1.5 Weld Finish & Repair The size and magnitude of weld leaks found shall be reported to the ITER Vacuum RO and no weld repairs shall be carried out without prior agreement. All weld repairs shall be qualified in accordance with the relevant design and construction codes where applicable, and with Section 7.1.2 above. Where RCCMR or ASME VIII is not applied, if a weld leak is found, the repair procedure shall be subject to specific acceptance by the ITER vacuum RO as well any other relevant approvals. The size and magnitude of all leaks found on welds forming a vacuum boundary shall be reported to the ITER Vacuum RO. All repair welds forming part of a vacuum boundary shall be qualified in accordance with the relevant design and construction codes where applicable, and with Section 7.1.2 above. Where RCCMR or ASME VIII is not applied, if a weld leak is found, the repair procedure shall be subject to specific acceptance by the ITER vacuum RO as well any other relevant approvals. 9 Confinement and Vacuum Containment VQC 2A components that are considered to be vulnerable shall

			normally be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System. VQC 2A components that are considered to be vulnerable are recommended to be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System. 12 Pipework Where practical, for components classified as VQC 2A, water pipes forming part of the cryostat vacuum boundary shall be doubly contained. Where it is not practical to doubly contain the pipework, all welded joints shall be full penetration butt welds subject to 100% Non-Destructive Testing (NDT). It is recommended that pipework classified as VQC 2A, water pipes forming part of the cryostat vacuum boundary, be doubly contained. Where the pipework is not doubly contained, all welded joints shall be full penetration butt welds subject to 100% Non-Destructive Testing (NDT). 17.2 Design of Bellows All vulnerable bellows for use on VQC 1 and 2 systems shall be of double construction (or accepted multilayer design) with a monitored interspace, unless they are accessible for maintenance and fitted behind an approved interlocked isolating valve. Where vulnerable bellows are be used on VQC 2 systems it is recommended that they be of double construction (or accepted multilayer design) with a monitored interspace.
v2.4	Revision Required	10 Dec 2018	Updated to include changes reviewed under scope of mPCR 260 Change Notice "PCR-M260 - Application of ITER Vacuum Handbook to standard products, clarification of requirements and minimal update to reflect the phase of the ITER project" for "ITER Vacuum Handbook (2EZ9UM v2.3)": review and approval (SK47R3 v1.0)
v2.5	Approved	28 May 2019	No change from V 2.4. v2.5 is v2.3 plus changes introduced by mPCR 260. V2.5 is to be applied for future contracts/PAs.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 1 of 48



ITER Vacuum Handbook

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 2 of 48

1	Background	6
2	Scope of this Handbook	6
2.1	Communications and <i>Acceptance</i>	7
3	Vacuum Classification System (VQC)	7
3.1	Definition	7
3.2	Notification of the Vacuum Classification	8
3.3	Components without a Vacuum Classification	8
3.3.1	Supply	8
3.3.2	Connections Between Systems	9
4	Deviations and Non-Conformances	9
5	Materials for Use in Vacuum	9
5.1	Materials Accepted for Use in Vacuum	9
5.2	Adding Materials to the Accepted List for Vacuum	9
5.3	Metallic Machined Components and Fittings	10
5.3.1	Final Thickness < 5 mm	10
5.3.2	Final Thickness between 5 mm and 25 mm	10
5.3.3	Manufacture of Vacuum Flanges	10
5.4	Outgassing	11
5.5	Hot Isostatic Pressing	12
5.6	Castings	12
5.7	Plate Material	12
6	Cutting and Machining	13
6.1	Use of Cutting Fluids	13
6.1.1	General	13
6.1.2	VQC 1 and 3 Cutting Fluids	13
6.1.3	VQC 2 and 4 Cutting Fluids	14
6.2	Cleaning Prior to Joining	14
7	Permanent Joining Processes	14
7.1	Welded Joints	14
7.1.1	Joint Configuration	15
7.1.2	Qualification of Welding Processes	16
7.1.3	Selection of the Welding Process	16
7.1.4	Inspection and Testing of Production Welded Joints	16
7.1.5	Weld Finish & Repair	17
7.1.6	Helium Leak Testing of Production Welds	17
7.1.7	Helium Leak Testing after Repair of Welds	18
7.2	Brazed and Soldered Joints	18
7.2.1	Design of Brazed Joints	18
7.2.2	Qualification of Brazed joints	18
7.2.3	Inspection and Testing of Brazed Joints	19

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 3 of 48

7.3	Diffusion Bonding	19
7.4	Explosion Bonding.....	19
7.5	Adhesive Bonding	19
8	Surface Finish	19
8.1	Surface Roughness.....	19
8.2	Coatings	20
9	Confinement and Vacuum Containment.....	21
10	Trapped Volumes	22
11	Connections to the Service Vacuum System.....	22
12	Pipework (Pipe & Fittings)	23
12.1	General	23
12.2	Pipework Sizes	23
13	Demountable Joints.....	23
14	Fasteners and Fixings	24
14.1	Tapped Holes	24
14.2	Bolts	25
14.2.1	Bolts for use on the Vacuum Boundary ($P < 0.15$ MPa).....	25
14.2.2	Prevention of Bolt Seizing	25
14.2.3	Bolt Locking.....	25
14.3	Riveting	25
14.4	Bearings and Sliding Joints	25
15	Windows and Window Assemblies	26
15.1	General	26
15.2	Qualification of Window Assemblies.....	26
15.3	Testing of Window Assemblies	26
16	Vacuum Valves and Valve Assemblies	27
16.1	Acceptance Testing of Vacuum Valves and Valve Assemblies	27
17	Bellows and Flexibles	28
17.1	General	28
17.2	Bellows Protection.....	28
17.3	Design of Bellows.....	28
17.4	Qualification of Bellows	29
17.5	Testing & Inspection of Bellows.....	29
17.6	Bellows Protection.....	30
18	Feedthroughs	30
18.1	General	30
18.2	Paschen Breakdown	30
19	Electrical Breaks.....	30
20	Cables for use in Vacuum	31

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 4 of 48

20.1	General	31
20.2	Connectors and Terminations	31
21	Interconnection between VQC 1 systems.....	32
22	Proprietary Components.....	32
23	Vacuum Instrumentation.....	32
24	Cleaning and Handling	33
24.1	Cleaning	33
24.2	Design Rules for Cleanability	33
24.3	Mechanical Processes on Vacuum Surfaces	34
24.4	Pickling/passivation of Steels and Copper	34
24.5	Post-Cleaning Handling of Vacuum Equipment	34
24.6	Cleanliness during the Assembly of Vacuum Equipment	35
25	Leak Testing.....	35
25.1	General	35
25.2	Maximum Acceptance Leak Rates	36
25.3	Design Considerations for Leak Testing.....	36
25.4	Scheduling of Leak Tests	37
25.5	Methods and Procedures	39
25.6	Acceptance Leak Testing at the <i>Supplier's</i> Premises.....	40
25.7	Acceptance Criteria for Leak Testing	40
25.8	Acceptance Leak Testing at the ITER site	41
25.9	Reporting of Leak Tests	41
26	Baking	42
26.1	General	42
26.2	VQC 1 Components (non plasma-facing).....	42
26.3	VQC 1 Components (plasma-facing).....	43
26.4	VQC 2 Components	43
26.5	VQC 3 Components	43
26.6	VQC 4 Components	44
26.7	Vacuum Conditioning of Carbon Composites.....	44
26.8	Documentation to be Supplied for Vacuum Baking	44
27	Draining and Drying.....	44
27.1	Design Considerations for Draining and Drying	44
27.2	Components Delivered to ITER.....	45
28	Marking of Vacuum Equipment	45
29	Packaging and Handling of Vacuum Equipment	45
30	Incoming Inspection at ITER of Vacuum Equipment	46
31	Long Term Storage of Vacuum Equipment	47

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 5 of 48

32	QA and Documentation	47
33	Acknowledgements	47
34	List of Attachments	48
35	List of Appendices	48

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 6 of 48

1 Background

ITER will include one of the largest and the most complex high vacuum systems ever built. Reliable vacuum is key to the success of the ITER project. A characteristic of high vacuum is that the functionality of a whole system can be lost by not appreciating and paying attention to the effect of small details. Due to the pervasive nature of vacuum in the ITER machine, there are very few ITER systems which will not have an important vacuum interface. Orders of magnitude improvements in vacuum reliability are required compared to existing and past fusion devices to achieve the ITER goals because of the scaling in the number of components and the physical size of ITER.

There are two main vacuum systems on ITER, the Torus primary vacuum which requires ultra-high vacuum (UHV) conditions, and the cryostat primary vacuum which requires clean insulation vacuum conditions with permissible operating pressures typically 2 orders of magnitude higher than the torus. In addition, there are secondary vacuums and a cryogenic guard vacuum system. Details are given in Appendix 1.

2 Scope of this Handbook

This Vacuum Handbook outlines the mandatory requirements for the design, manufacturing, testing, assembly and handling of vacuum items to realise and subsequently to maintain the various different ITER vacuum systems. In addition, this Handbook provides significant guides and helpful information which can be used in the production of procurement specifications for ITER components.

The ITER Vacuum Handbook is issued as a high level project requirements document since it is imperative that the requirements contained in this Handbook are followed by the International Organisation, the Domestic Agencies and Industries to ensure that ITER operations are ultimately successful.

This Handbook is supported by a set of Attachments and Appendices. The Attachments are subject to the same approval process as the main handbook and contain detailed mandatory requirements. With the exception of Appendices 3 & 4 the Appendices are for guidance and provide detailed information, guides, specifications, relevant processes and lists of standard and approved components, vacuum materials, etc. Appendices 3 & 4 contain lists of materials (and associated processes) which have been approved for use on, or in, the ITER vacuum systems. Only materials (or associated processes) listed in Appendices 3 & 4 shall be used in, or on ITER vacuum systems. All Appendices are working documents subject to regular update.

The Appendices can be used by *suppliers* to aid the production of vacuum components, specifications and procedures which satisfy the mandatory requirements of the ITER Vacuum Handbook.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 7 of 48

2.1 Communications and *Acceptance*

To satisfy the requirements of this handbook *acceptance* or *accepted* is called for in various places, this *acceptance* is to be given by the ITER Vacuum Responsible Officer (RO) or his or her nominated representative. *Acceptance* is to be a positive and recorded action, either by signature or by electronic means. The ITER Vacuum RO will respond in the shortest possible time from receipt of the request, normally within two weeks. An explanation will be provided if the proposal is rejected or if modification is required.

Requests for *Acceptance* shall be sought through the submission of the Request for *Acceptance* (ITER_D_9AY4HD).

Where the Interface compliance check list of an ITER Procurement Arrangement is signed by the ITER Vacuum Responsible officer this shall be taken as *acceptance* of these items which are detailed in the Procurement Arrangement. Where an ITER Procurement Arrangement does not provide adequate details required for *acceptance* of these items, then the PA can define the processes to be followed leading to *acceptance* in which case these processes shall be followed rather than processes of the ITER Vacuum Handbook.

Iterations with both the Domestic Agencies and industry are expected to be necessary to meet the requirements of this Handbook.

Normal communication and approval channels set up in any specific contract for supply should not be bypassed - rather that they should be the normal route by which *acceptance* requests are made and received.

A possible route of communication and acceptance would therefore be:-

Supplier (Contractor) ↔ Domestic Agency Contract Responsible Officer ↔ ITER Technical Responsible Officer ↔ ITER Vacuum Responsible Officer.

A definition of terms can be found in Appendix 21.

3 Vacuum Classification System (VQC)

3.1 Definition

Every vacuum component is given a Vacuum Classification to denote its area of service on ITER. These are defined as:

VQC 1X: Torus primary vacuum components or components which become connected to the torus high vacuum through the opening of a valve during normal operations.

VQC 2X: Cryostat primary vacuum components or components which become connected to the cryostat vacuum through the opening of a valve during normal operations.

VQC 3X: Interspaces and auxiliary vacuum systems connected to the service vacuum system or roughing lines.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 8 of 48

VQC 4X: Cryogenic guard vacuum systems or items connected to the cryogenic guard vacuum system.

VQC N/A: Components not exposed to vacuum.

Where:

X = A denotes boundary components.

X = B denotes components within vacuum but which do not form part of the vacuum boundary.

Where a component is part of the boundary between two different vacuum classes, it shall normally meet the more demanding requirements of the higher class unless the division between classes is shown on the drawings. Joints which separate classes shall always be classified according to the requirements of the more demanding class. The surface finish requirements appropriate to each class are to be applied. Surface cleaning of the less highly classified surface may be in accordance with the reduced requirements of that classification provided that the more highly classified surface is not degraded in the process.

Some examples of classification are:

- In vessel divertor cassette water cooling pipe - VQC 1A.
- In-vessel remote handling rail - VQC 1B.
- Cryogenic lines within the cryostat - VQC 2A.
- Support within the cryostat - VQC 2B.
- Cryogenic transfer-line between cryo-plant and tokamak complex - VQC 4A.

Typical base pressures and pumping speeds for the various vacuum systems are given in Appendix 1.

3.2 Notification of the Vacuum Classification

The VQC for a particular component shall be marked on any drawing related to and stated in any specification for that component. If this is not the case, the classification can be provided by the ITER Vacuum Responsible Officer (RO) upon request.

3.3 Components without a Vacuum Classification

3.3.1 Supply

In order ensure vacuum components which are intended for service on ITER and are not classified under section 3 (such as, for e.g., mechanical displacement pumps), meet the requirements for safety and performance the IO shall approve Technical Specifications for the supply of such equipment. Technical Specifications shall be submitted to the ITER Vacuum RO for review and subsequent approval prior to the commencement of the procurement process.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 9 of 48

3.3.2 Connections Between Systems

An item of vacuum equipment which is not classified under section 3 may be connected to an item with a VQC, e.g. a leak detector may be connected to a valve on the cryostat or a roughing pump may be connected to the torus vacuum system. In all such cases, the use of such items and the operations for which they are required shall be under administrative control. A written scheme of work shall be submitted on the appropriate form to the ITER Vacuum RO. The main criterion for approval of such a scheme of work (other than the necessity of the work being carried out) shall be an assessment by the ITER Vacuum RO of the possibility of contamination of the system bearing the VQC.

4 Deviations and Non-Conformances

Requests for deviations from, and non-conformance with, the requirements of the ITER Vacuum Handbook shall be made to the ITER IO in writing following the procedures detailed in the ITER Quality Assurance Program (IDM Ref: ITER_D_22K4QX) and ITER Deviations and Non-Conformances (IDM Ref: ITER_D_22F53X) documents. Recommendations on the approval of the non-conformance report will be made by the ITER Vacuum RO.

5 Materials for Use in Vacuum

5.1 Materials Accepted for Use in Vacuum

Only materials *accepted* for the relevant Vacuum Classification shall be used on ITER vacuum systems. All material for use in vacuum shall be clearly specified at the design stage and certified in accordance with EN 10204 3.1 or 3.2 before being used in manufacturing.

Materials which may be used without prior agreement on vacuum systems with the Vacuum Classifications stated in the table are listed in Appendix 3. Materials listed in this Appendix which are shown as being subject to restricted use for a particular Vacuum Classification are subject to either an overall quota or to particular restrictions on their position of use. *Acceptance* for any particular vacuum application of such a material shall be obtained by submitting the Material Acceptance Request Form (ITER_D_2MGWR4) to the ITER Vacuum RO. An example of this completed form is to be found in Appendix 3.

5.2 Adding Materials to the Accepted List for Vacuum

Materials which are not on the accepted list may be proposed for use in vacuum. If the vacuum properties of the material are not sufficiently well documented for an assessment to be carried out, a programme of measurement of the relevant properties shall be agreed between the proposer and the designated ITER Vacuum RO.

Details of materials to be considered for acceptance shall be submitted to the ITER Vacuum RO using the Material Acceptance Request Form (ITER_D_2MGWR4). The

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 10 of 48

proposer shall agree in advance with the ITER Vacuum RO a plan detailing the type and method of testing to be used to qualify the material for use. The Materials Acceptance Request Form along with the test data, report and supporting documentation, including any *supplier's* data (Certificates of Conformity, etc.), shall be submitted for consideration. These shall be assessed by the ITER Vacuum RO who will communicate the acceptance, refusal or restrictions on usage of the material to the originator of the request.

Materials qualified in this way may be added to Appendix 3.

5.3 Metallic Machined Components and Fittings

5.3.1 Final Thickness < 5 mm

All VQC 1A components which are machined from steel, austenitic steel or superalloys and which are of final thickness less than 5 mm and VQC 2A components which are machined from steel, austenitic steel or superalloys and which are of final thickness less than 2 mm and are designed to contain cryogenic helium¹, shall be made from cross-forged material which is Electro-Slag Remelted (ESR) or Vacuum Arc Remelted (VAR).

The rate of inclusions in such steels shall be checked in accordance with ASTM E-45 Method D (or equivalent) to be within the following inclusion limits:

- Inclusion Type A ≤ 1.0 .
- Inclusion Type B ≤ 1.0 .
- Inclusion Type C ≤ 1.0 .
- Inclusion Type D ≤ 1.5 .

These requirements are summarised in Table 5-2.

5.3.2 Final Thickness between 5 mm and 25 mm

VQC 1A components which are machined and are of final thickness between 5 mm and 25 mm shall be manufactured from approved steel (listed in Appendix 3), in the form of stock which has been cross-forged (upset forged).

These requirements are summarised in Table 5-2.

5.3.3 Manufacture of Vacuum Flanges

Both halves of demountable flanges using metal seals are to be manufactured from cross or upset forged material.

¹ At the time of writing this requirement is under approval and shall be included to the next version of this Handbook.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 11 of 48

Stainless steel used for the manufacture of knife-edge sealed flanges of any thickness for all vacuum classifications shall be from cross-forged ESR grade material blanks.

5.4 Outgassing

The outgassing rates of materials used on ITER vacuum systems shall be consistent with the values in Table 5-1. Appendix 17 gives details on how outgassing requirements are derived, how they can be achieved and how they may be measured.

		Maximum Steady State Outgassing rate $\text{Pa.m}^3.\text{s}^{-1}.\text{m}^{-2}$		
VQC ⁺	Outgas temperature °C	Hydrogen isotopes	Impurities	Testing Guidelines
1	100 [‡]	1×10^{-7}	1×10^{-9}	Appendix 17
2	20	$1 \times 10^{-7*}$		Appendix 17
3	20	1×10^{-8}		Appendix 17
4	20	1×10^{-7}		Published data and conformity to clean work plan.

For VQC 2, 3 and 4, the outgassing rate excludes the partial outgassing rates for water and hydrogen.

‡ The outgas test temperature can be reduced to 20 °C for components which normally operate at cryogenic temperatures.

+ For CFC refer to section 26.7

* In the case of resins for magnets it is considered that this target outgassing rate will be achievable. However, a factor of 10 increase will be permitted as an acceptance criterion.

Table 5-1 - Outgassing rates pertaining to VQC

These limits have been produced by taking into account the total surface area expected, the available pumping speed, the desired pressure and post assembly conditioning time, with due consideration of what is reasonably achievable. The addition of novel high surface area components to the design requires specific *acceptance* and appropriate limits to be assessed.

Published data and/or experimental trials shall be used to show design and process consistency with the limits.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 12 of 48

An outgassing rate acceptance test shall be performed for all VQC 1 components to an *accepted* procedure such as those described in Appendix 17. Exceptions will be *accepted* for components which normally operate at a pressure above 1 Pa. Outgassing acceptance tests may, with prior *acceptance*, be performed using representative samples which follow, and are subjected to, the complete manufacturing process.

Where it is agreed that a specific vacuum component should not be subjected to a specific outgassing rate acceptance test, compliance shall be demonstrated by conformity to a clean work and quality plan.

5.5 Hot Isostatic Pressing

Hot Isostatic Pressing (HIP) of sintered material is allowable for use on all VQC components, provided that it is demonstrated that the components meet the mechanical and leak rate requirements for the proposed application and the vacuum boundary thickness is greater than 5mm. It must be demonstrated that HIP formed components comply with the outgassing rates in Table 5-1. Proposals for the use of HIP formed components, and the procedure for qualification of the components for use as vacuum containment, shall be subject to prior *acceptance* at the design stage.

These requirements are synopsised in Table 5-2.

5.6 Castings

For VQC 1, 2A & 3, metallic castings shall not normally be used. Where it is considered that a casting technology could provide acceptable porosity and meet the outgassing and leak rate requirements in the final application, then a vacuum properties validation program shall be proposed for *acceptance*.

These requirements are synopsised in Table 5-2.

5.7 Plate Material

Where hot or cold rolled plate material is used, it is recommended for all vacuum classes, that a surface parallel to the direction of rolling forms the vacuum boundary. This is due to the possibility of long leak paths caused by the stratification of inclusions.

For VQC1A applications which have been assigned Remote Handling Class 3 or are Non-RH classified (ITER_D_2FMAJY) where the component becomes embedded in ITER and could not in future be changed, hot or cold rolled plate material (approved steels from Appendix 3) produced with conventional smelting and refining processes such as Argon-Oxygen Decarburization (AOD), Vacuum Arc decarburization (VOD)) shall not be used where the transverse cross section across the vacuum boundary (wall thickness) is less than 25mm.

Where for VQC1A hot or cold rolled plate material (approved Steel – Appendix 3) is used with the transverse cross section crossing the vacuum boundary (wall thickness less than 25 mm), ESR or VAR low inclusion rate material shall be used which meets

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 13 of 48

the inclusion limits as specified in Section 5.3.1 The component shall also be proven by leak testing in an environment which conforms as closely as possible to the operating conditions (See Section 25) with due consideration taken of the effects of possible leaks along laminations on the response time for the test method.

These requirements are synopsised in Table 5-2.

Nominal thickness (of vacuum boundary)		Plate / Bar ¹			Forging ⁴	Pipe ⁴	Pipe, ^{4,5} (He, ≤ 2 mm)	HIP ³	Casting ⁴
	Direction	Crosses ²		Parallel ²					
	RH Class	3, N/A	1, 2	1, 2, 3, N/A					
≤ 5 mm		X	L	NR	F + L	NR	L	X	A
>5 mm ≤ 25 mm		X	L	NR	F	NR	NR	A	A
> 25 mm		L	NR	NR	NR	NR	NR	A	A

¹VQC 1A, VQC 2A cryogenic helium pipework (pipe & fittings) < 2 mm
²Transverse cross section w.r.t. vacuum boundary or parallel w.r.t vacuum boundary
³All VQC
⁴ VQC 1A,2A &3A
⁵ Helium coolant, thickness less than 2 mm.
X=Not Allowed
F=Cross or Upset Forged
L= Low inclusion in compliance with 5.3.1 and ESR/VAR remelting
A=requires *acceptance*
NR = No requirement
N/A – not applicable

Table 5-2 Synopsised requirements pertaining to metallic components

6 Cutting and Machining

6.1 Use of Cutting Fluids

6.1.1 General

Care must be taken in manufacturing processes so as not to introduce contaminants into surfaces which may be difficult to remove later and which might result in degraded vacuum performance.

6.1.2 VQC 1 and 3 Cutting Fluids

Cutting fluids for use on VQC 1 and 3 systems shall be water soluble, non-halogenated and phosphorus and sulphur Free. The maximum allowable content of halogens, phosphorus, and sulphur is 200 ppm (each)

Accepted cutting fluids for use in VQC 1 and 3 vacuum applications are listed in Appendix 4. The use of other cutting fluids requires prior *acceptance*.

Acceptance for the use of any particular non-approved cutting fluid shall be obtained by submitting the Fluid Acceptance Request Form (ITER_D_48XLVJ) to the ITER Vacuum RO. An example of this form is to be found in Appendix 4.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 14 of 48

6.1.3 VQC 2 and 4 Cutting Fluids

For VQC 2 & 4 vacuum applications it is recommended that cutting fluids be water soluble, non-halogenated and phosphorus and sulphur free (< 200 ppm for each). They should be chosen from those listed in Appendix 4. Where this recommendation is not followed particular care shall be taken to ensure the appropriateness of the cleaning procedures (See section 24).

6.2 Cleaning Prior to Joining

To minimise the risk of trapped contamination which can subsequently cause leaks or enhanced outgassing, parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralised water, and dried prior to joining in accordance with Section 24 below. The use of halogenated solvents is forbidden at any stage for systems of class VQC 1 and 3. Accepted fluids are listed in Appendix 4.

7 Permanent Joining Processes

Permitted joining techniques for vacuum applications and their applicability to each VQC are shown in Table 7-1. Proposals for joining techniques not listed here shall be submitted for prior *acceptance*.

7.1 Welded Joints

Lack of attention to the details of vacuum sealing weld design, qualification and testing has proved to be a significant cause of vacuum leaks on vacuum systems.

All vacuum welds, except those excluded below, shall be qualified, produced and inspected in accordance with Attachment 1. The requirements of Attachment 1 are mandatory until superseded by the ITER baseline Welding Handbook.

Where there is regulatory requirement to design and subsequently build a vacuum system to RCC-MR or ASME VIII, the requirements of these codes shall take precedence over the requirements of Attachment 1, while remaining in compliance with Section 7.1.6. In other cases where vacuum sealing welds are to be qualified, produced and inspected to meet a code, and there is variation between the requirements of the code and Attachment 1, the more extensive or stringent requirements shall be applied.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 15 of 48

	VQC 1		VQC 2		VQC 3		VQC 4	
	A	B	A	B	A	B	A	B
Welded joints	✓	✓	✓	✓	✓	✓	✓	✓
Brazed/soldered joints	†	†	†	‡	✓	✓	✗	✓
Diffusion bonding	✓	✓	✓	✓	✓	✓	✓	✓
HIP	✓	✓	✓	✓	✓	✓	✓	✓
Compression joints	✗	✗	†	†	✓	✓	✓	✓
Adhesive bonding	✗	†	†	†	†	†	†	†
Explosion bonding	✓	✓	✓	✓	✓	✓	✓	✓
✓ - indicates an acceptable technique ✗ - indicates an unacceptable technique † - application specific <i>acceptance</i> required ‡- For soldering of super conducting joints see Section 7.2								

Table 7-1 Joining methods applicable to VQC

7.1.1 Joint Configuration

The use of welds from both sides makes leak testing difficult and enhances the risk of trapped volumes forming virtual leaks or contaminant traps that are to be avoided. Thus, for all vacuum classes, vacuum sealing welds shall be either internal (i.e. facing the vacuum) or external. In VQC 2, double sided welding may be used where unavoidable, but an NDT inspection schedule giving 100% volumetric examination must be used to ensure that a full-thickness melt zone has been achieved.

The use of stitch welds on the vacuum facing side is prohibited.

For VQC 1A, VQC 2A and VQC 3A on the boundary to air or water, full penetration welds are required.

For VQC 4A (process to insulation vacuum) welds full penetration welds are required.

It is good engineering practice to design joints to be accessible for repair if necessary.

Butt welded joints are preferred to fillet or lap joints, since testability is improved. Fillet, corner, lap and cross joints should be avoided wherever possible on VQC 1 systems.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 16 of 48

Welds shall normally be made in such a way that they can be leak tested at the time of completion. Welds that cannot be inspected (see Sections 7.1.4 & 7.1.6) are not permitted for use on VQC 1 and VQC 3 and should be minimised for use on VQC 2 and VQC 4. Where leak detection is not practical at the time of completion, a test plan including provision for repair of the weld must be *accepted* at the design stage.

7.1.2 Qualification of Welding Processes

Qualification of welding processes for use on vacuum sealing welds shall follow the requirements of Attachment 1 and section 7.1.

A welding and inspection plan shall always be submitted to the ITER IO.

7.1.3 Selection of the Welding Process

The selected welding technique for vacuum applications (e.g. electron beam, laser or TIG welding) should produce a clean, pore free weld with minimal oxidation. Autogenous welding shall be used where practical.

7.1.4 Inspection and Testing of Production Welded Joints

All such inspection and testing shall be carried out using approved procedures in accordance with Attachment 1.

For all VQC 1A, VQC 2A water boundaries, vacuum boundary welds which become inaccessible and VQC2A cryogenic pipework connections, 100% volumetric examination of production welds shall be performed, unless a method of pre-production proof sampling is approved.

For VQC 4A (process to insulation vacuum) 100% volumetric examination of production welds shall be performed, unless a method of pre-production proof sampling is approved.

The range of thickness and preferred volumetric examination method to be applied is given in Table 7-2.

Wall Thickness (wt) (mm)	Preferred Volumetric Examination Method
wt < 8	Radiography
8 < wt < 19	Radiography & Ultrasonic
wt > 19	Ultrasonic or radiography
Note: For wt > 19 mm ultrasonic examination of welds is preferred only in cases where radiographic examination would require excessive exposure times.	

Table 7-2 Range of wall thickness and preferred volumetric examination method to be applied

For all other vacuum boundaries, volumetric examination of 10% of production welds shall be performed with the wall thickness limits specified in Table 7-2, unless a method of pre-production proof sampling is agreed by the ITER IO.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 17 of 48

On welds forming the vacuum boundary the use of liquid penetrant testing (LPT) or magnetic particle techniques shall not in general be permitted for the inspection of welds or in the inspection of weld preparations. This is because such substances may block leaks temporarily and can be difficult to remove satisfactorily.

Where there is a mandatory requirement to build a component to a code then the flexibility of the code to avoid the use of LPT on welds forming the vacuum boundary shall be a key factor in the assessment of that code for selection. The selection process shall be recorded and *accepted*.

Where a code selected for building a component requires the use of a qualified surface examination method, and LPT cannot be avoided, only the ITER vacuum qualified liquid dye penetrant (see Appendix 4) may be used. If the use of LDP is permitted, then cleaning must be performed to procedures qualified and subsequently *accepted* by the ITER Vacuum RO.

For VQC 1B welds which are subject to high cyclic stresses, the use of ITER qualified LDP for detection of surface defects is permitted subject to notification of this application to the ITER Vacuum RO.

For VQC 2B and 4B the use of ITER qualified LDP is permitted. The method of application and subsequent removal of LDP shall be performed to procedures qualified and *accepted* by the ITER Vacuum RO.

7.1.5 Weld Finish & Repair

Production welds used on all vacuum systems shall be left clean and bright but there is no vacuum requirement to machine the weld zone to match the surface finish of the parent material.

All weld regions shall be free from scale, voids, blowholes, etc., and there shall be no visible evidence of inclusions.

The size and magnitude of weld leaks found shall be reported to the ITER Vacuum RO and no weld repairs shall be carried out without prior agreement.

All weld repairs shall be qualified in accordance with the relevant design and construction codes where applicable, and with Section 7.1.2 above. Where RCCMR or ASME VIII is not applied, if a weld leak is found, the repair procedure shall be subject to specific *acceptance* by the ITER vacuum RO as well any other relevant approvals.

7.1.6 Helium Leak Testing of Production Welds

All vacuum sealing welds in each VQC shall be subject to helium leak testing in accordance with the procedures of Section 25.

Where multi-pass welding is required in the production of components of VQC 1A and VQC 2A, it is recommended that leak testing of the root weld pass shall be performed with only this pass completed. However, for multi-pass welding that takes place on the ITER site, this requirement is mandatory.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 18 of 48

If it has been agreed that liquid dye penetrant may be used for testing such a weld (see Section 7.1.4), the root weld leak test shall be performed before the application of this liquid.

Any leak which is found in the root weld to be above the minimum detectable leak rate of the equipment which has been *accepted* for use in the *accepted* procedures for such tests, must be repaired and re-tested before proceeding with further weld passes.

In all cases, a further leak test shall be carried out (see Section 25).

7.1.7 Helium Leak Testing after Repair of Welds

All repaired vacuum boundary welds shall be subject to full vacuum leak testing in accordance with the procedures of Section 25.

7.2 Brazed and Soldered Joints

Brazing shall be carried out in a vacuum, hydrogen or inert gas atmosphere. Torch brazing is not permitted except where unavoidable for VQC 2B. Where the use of brazing flux is unavoidable a cleaning procedure shall be qualified and submitted for *acceptance* to the ITER vacuum RO.

Brazing materials which contain silver are subject to specific quotas for components for VQC 1, 2 or 3 in systems where the irradiation environment may lead to significant silver transmutation to cadmium. The use of such materials is subject to prior *acceptance*.

Brazing is not permitted for any water to vacuum joint in VQC 1, 2 or 3.

Brazing is not permitted for VQC 4A where there is contact with cryogenic fluid.

All brazing techniques shall be to an *accepted* standard or to a procedure *accepted* prior to manufacture.

On account of the relatively high vapour pressure of the solder, soft soldering (< 400°C with Sn, Zn, alloys of Pb, Cd, etc) shall not be permitted for VQC 1 or VQC 2A, or VQC 3A and is only allowable on VQC 2B for applications which operate at a temperature < 60 K.

7.2.1 Design of Brazed Joints

The design of brazed joints shall be such as to minimise the risk of trapped volumes.

7.2.2 Qualification of Brazed joints

All brazing techniques shall be qualified to an *accepted* standard or to an *accepted* qualification programme. Tests on pre-production samples of brazed joints shall be performed to *accepted* procedures or to an *accepted* standard. Brazing procedure qualification shall be compliant with EN 13134:2000 (or equivalent).

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 19 of 48

7.2.3 Inspection and Testing of Brazed Joints

Brazed joints shall be subject to qualification to ensure the vacuum integrity of the joint.

All brazed joints shall be inspected visually to ensure that the vacuum exposed braze regions are clean, flush and free from voids, blowholes, etc., that there is no visible evidence of inclusions and that the braze material has filled the joint without excessive over-run.

Where practicable, radiography of an agreed percentage sample of brazed joints shall be carried out. Where this is not practicable, then samples shall be produced for sectioning and microscopic examination.

The use of liquid dye penetrant or magnetic particle techniques shall not be permitted for the inspection of brazed joints or in the inspection of joint preparations.

All brazed joints which form part of a vacuum boundary shall be subject to 100% helium leak testing.

No braze shall be re-run for rectification of any sort without prior agreement.

7.3 Diffusion Bonding

Diffusion bonding of joints is acceptable for all VQC. If it is used, diffusion bonded inter-layers shall comprise materials listed in Appendix 3. Diffusion bonded joints shall be subject to the same vacuum qualification procedures as brazed joints to ensure the integrity of the joint and compliance with the requirements of this Handbook.

7.4 Explosion Bonding

Explosion bonding of metals is acceptable for all VQC. Explosion bonded joints shall be subject to the same vacuum qualification process as brazed joints to ensure the integrity of the joint and compliance with the requirements of this Handbook. Existing qualifications of the process may be used for VQC2 applications if compliant with the requirements of this Handbook.

7.5 Adhesive Bonding

Adhesive bonding may only be used in limited circumstances (see Table 7-1) and using materials listed in Appendix 3.

8 Surface Finish

8.1 Surface Roughness

Metallic components for different VQC shall be supplied with the maximum average surface roughness listed in Table 8-1. Surface roughness is defined in accordance with ISO 4287: 2000.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 20 of 48

Classification	Maximum average Surface Roughness Ra (μm)	Measurement Technique
VQC 1	6.3	Electric stylus
VQC 2	12.5 [†]	Electric stylus
VQC 3	12.5	Electric stylus
VQC 4	12.5	Electric stylus
[†] Where to satisfy this surface roughness requirement additional machining would be required a rougher surface is accepted provided the surface is easily cleanable and can be shown not to catch fibres when wiped with a lint free cloth.		

Table 8-1 - Maximum permissible average surface roughness for metals

Generally, where the base material is not produced with an acceptable surface finish, such surface finishes may be achieved using techniques including:

- Machining.
- Electropolishing.
- Bead Blasting in a slurry in a water jet with alumina or glass beads.
- Surface Passivation / Pickling (see Section 24.4).

All processes on vacuum surfaces shall be followed by appropriate cleaning of the surface (see Section 24 below).

8.2 Coatings

Only materials accepted by ITER for the relevant Vacuum Classification shall be used for coatings on ITER vacuum systems (see Section 5).

Surface coatings for VQC1 shall be subject to qualification and *acceptance* at the design stage. The assessment of the coating shall include consideration of :-

- The risk of the coating producing trapped volumes and temporary leak blocking.
- The method of applying the surface coating (e.g. painting, chemical, plasma spray, etc.).
- The chemical composition, morphology, cleaning and outgassing of the surface coating.
- Conformance of the coating with the ITER outgassing requirements as detailed in Section 5.4.
- The method for testing the adhesion of the surface coating to the substrate.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 21 of 48

9 Confinement and Vacuum Containment

Confinement is the term used for the physical enclosure of hazardous substances (e.g. tritium).

“Vacuum containment” is a term used for vacuum tight boundaries which cope with differential pressure in either direction. Vacuum containment may also provide a confinement function.

Vulnerable components are generally considered to be those components which have been shown to exhibit a failure rate higher than 10^{-5} per year in an experimental environment and typically include windows, bellows, lip seals, flexible hoses, metallic to non-metallic joints, feedthroughs, electrical breaks, thin walled material (<1.5 mm), and demountable seals. Reliability data and references can be found in Appendix 18.

VQC 2 high voltage electrical breaks and high voltage feedthroughs are considered vulnerable only if they have a specified failure rate greater than 10^{-5} per year or have been shown, in the specific design proposed, to exhibit a failure rate greater than 10^{-5} per year.

VQC 1A components that are considered to be vulnerable shall be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System (see Section 11). This requirement is necessary to achieve overall machine reliability. Lip seals which are accessible for repair in port cells are excluded from this requirement but shall have provision for remote leak identification. If a vulnerable component is accessible for maintenance and fitted behind an approved, interlocked, isolating valve then *acceptance* may be sought for single vacuum containment.

Demountable joints on VQC 1A shall use double seals with the interspace monitored and connected to the Service Vacuum System.

Demountable joints shall not be used for water to vacuum boundaries for any vacuum class.

Boundaries between VQC 1A and VQC 2A components that are considered to be vulnerable shall be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System. This is a requirement to avoid an undetected leak of tritium into the cryostat vacuum.

VQC 2A components that are considered to be vulnerable are recommended to be doubly vacuum contained with a monitored interspace connected to the Service Vacuum System. Where it is considered that double vacuum containment increases the failure risk or failure consequences, then an alternative method to provide leak localisation and mitigation shall be proposed for *acceptance*.

An analysis of the probability of air ingress is required for safety and investment protection for any vacuum system which contains hydrogen and can reach a deflagration pressure above the design pressure. (For a 200 KPa design pressure the hydrogen isotope concentration limit is 1.5 mole/m³ for volumes or 0.8 mole/m³ for pipes). If the probability of air ingress is greater than 10^{-6} per year, then the probability shall be reduced by design. For example, measures such as double vacuum containment with a monitored interspace may be applied.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 22 of 48

The requirements of this Handbook for VQC 1A will generally satisfy the requirements for primary tritium confinement (also see ITER Tritium Handbook ITER_D_2LAJTW))5

The requirements of this Handbook for VQC 3A will generally satisfy the requirements for the temporary confinement of tritium in off-normal events and of levels expected to be permeated (also see ITER Tritium Handbook ITER_D_2LAJTW).

On ITER, the secondary tritium confinement function is generally performed by buildings, ventilation and detritation systems, and hence is not part of this Handbook.

Further information on requirements for the confinement of tritium can be found in the ITER Tritium Handbook (ITER_D_2LAJTW).

10 Trapped Volumes

For VQC 1 and VQC 2A, 3A and 4A, the design of any vacuum component shall avoid trapped volumes in vacuum spaces which could result in virtual leaks.

For VQC 2B, 3B and 4B, care in the design of any vacuum component shall minimise trapped volumes in vacuum spaces which could result in virtual leaks.

Communicating passages should be made between any potential trapped volume and the pumped volume. The design of welded and brazed joints shall be such as to avoid the risk of trapped volumes.

Care should be taken to avoid large areas of surface contact which, through imperfect flatness, can provide a trap for gas and impurities. Such surfaces, if required, should be channelled.

Where relief holes are necessary, these should preferably be in the “fixed” part of the work piece, rather than relying on, for example, the use of a vented screw which may be missed on assembly.

11 Connections to the Service Vacuum System

Interspaces, e.g. between double windows, double bellows, double-sealed valves, etc., should be designed to be connected to the Service Vacuum System (SVS) with a minimum of two independent connections in every case meeting the following requirements:

- Interspaces which have a total volume less than 50 L shall utilise 6 mm tube welded to 6 mm (1/4 inch) VCR male fittings.
- Where the interspace volume is between 50 L and 500 L, the connections to the SVS shall utilise 12 mm tube welded to 12 mm (1/2 inch) VCR male fittings.
- Interspaces with volume greater than 500 L shall be fitted with 40 mm tubes with flanges selected from those listed in Appendix 8 welded to the tubes.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 23 of 48

This requirement is valid for all interspaces except where the interspace is to be pumped to less than 5×10^{-1} Pa, in which case connections to the SVS shall be *accepted* by the ITER Vacuum RO.

12 Pipework (Pipe & Fittings)

12.1 General

In all applications in VQC 1A and VQC 2A and VQC 4A (process to insulation vacuum), pipe and fittings shall be seamless. Where this is not possible, specific *acceptance* is required to use seamed components which shall conform to the testing requirements of Section 7.1.4.

To mitigate risk of the loss of availability associated with water leaks in the cryostat, it is recommended that single contained water pipes do not pass through the cryostat.

Where practical, for components classified as VQC 2A, water pipework forming part of the cryostat vacuum boundary shall be doubly contained. Where it is not practical to doubly contain the pipework, all welded joints shall be full penetration butt welds subject to 100% Non-Destructive Testing (NDT).

Interspaces on VQC 2A water pipework shall be brought out to the port cells or pipe chase area and provision made for water detection, draining and temporary vacuum connection for vacuum leak testing the interspaces.

Where interspaces are not used as a method of water leak localization for water pipes passing through the cryostat, an alternative *accepted* method shall be integrated with the water pipe design.

For VQC 1A and VQC 2A, & VQC 4A (process to insulation vacuum) pipework of wall thickness less than 2.0 mm designed to contain helium, Electro-Slag Remelted (ESR) or Vacuum Arc Remelted (VAR) material shall be used for the pre-extruded material and the inclusion limits of Section 5.3 adhered to.

In the case of VQC 4 (atmosphere to insulation vacuum), there is no restriction on the use of seamed pipe provided that it conforms to the testing requirements of Section 7.1.4.

12.2 Pipework Sizes

To comply with the ITER standard vacuum flange dimensions as specified in Appendix 8, standard pipework sizes shall be used where practical. Standard pipe sizes are listed in Appendix 11.

13 Demountable Joints

Demountable vacuum joints i.e. quick release couplings, compression joints, transition couplings, flange pairs, etc. for use on ITER vacuum systems shall be *accepted* prior to use. Lists of standard joints are given in Appendix 8.

For VQC 1 and 2 there shall be no demountable vacuum joints within the vacuum.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 24 of 48

Vacuum joints for use on VQC 1, 2 and 3 systems shall use all-metal seals. In addition, vacuum joints for use on VQC 1A shall utilise a double seal arrangement, with the interspace connected to the Service Vacuum System consistent with Section 9 (Confinement and Vacuum Containment).

All demountable joints must be accessible for maintenance/testing.

In all cases the fixed sealing face of the vacuum joint shall be accessible for manned inspection and repair during periods of ITER maintenance.

Seal faces must have the requisite surface finish and cutting lay or lap direction for the seal design. Seal faces shall not be electropolished.

For VQC 4, demountable vacuum joints shall normally use all-metal seals, although the use of other types of seals is permitted subject to prior *acceptance*.

For all VQC, the reuse of metal seals is permitted for system testing only. However, the final mating of demountable vacuum joints shall be made using previously unused metal seals.

Where demountable vacuum joints are mated for testing purposes, the applied sealing bolt loading on the test flanges shall be consistent with the final sealing option utilised. Once the sealing flange is proven, temporary use of other sealing options can be permitted. When the item is in its operational position and a temporary seal is used this must be recorded using a non-conformance.

All demountable vacuum joints shall be subject to 100% helium leak testing to installation procedures following the guidelines specified in Appendix 12. Installation procedures shall be approved by the ITER Vacuum RO. A design guide for the manufacture of demountable joints and sealing options for use on ITER vacuum systems is given in Appendix 8.

14 Fasteners and Fixings

14.1 Tapped Holes

Blind tapped holes shall be avoided as far as possible, since in addition to being a source of virtual leaks (see Section 10), they provide a potential trap for contaminants. Where the use of blind holes is unavoidable, holes shall be tapped with flat bottoms and vented screws or bolts shall be used.

Tapped holes shall be cut using only the approved cutting fluids listed in Appendix 4. Cutting fluids not listed in Appendix 4 may be *accepted* in advance by the ITER Vacuum RO and submitted for inclusion in Appendix 4 using the procedure in Section 5.2. Where an insertion is used to provide a screw thread in a plain hole (e.g. Helicoil™ inserts), the material used shall be consistent with those listed in Appendix 3.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 25 of 48

14.2 Bolts

14.2.1 Bolts for use on the Vacuum Boundary ($P < 0.15$ MPa)

It shall be demonstrable that bolts for use in the formation of a vacuum boundary are of satisfactory mechanical properties to provide the relevant seal force requirements of Appendix 8. Bolts should be of rolled thread and supplied with certification in accordance with EN 1024, 3.1.

14.2.2 Prevention of Bolt Seizing

For all VQC, threaded fixings (e.g. bolts), shall be treated to prevent seizing. Approved solid (dry) lubricants, aluminium bronze inserts or coatings are preferred. Lubricants for each class are listed in Appendix 3. The use of any other lubricant is subject to prior *acceptance*. Bolts for use on ITER vacuum systems but not exposed to vacuum (i.e. VQC N/A), shall be lubricated to prevent seizing with a hard coating or, where appropriate, Molykote[®].

14.2.3 Bolt Locking

It is recommended that bolts in vacuum for use on VQC 1 and VQC 2 systems shall be locked after loading to prevent them becoming free and causing damage to other parts of the vacuum system. Bolts may, for example, be locked using resistance spot welded stainless steel tangs. Other suitable materials may be selected from those listed in Appendix 3.

14.3 Riveting

Riveting is an approved technique for the joining of components in VQC 2B and 3B. Rivets shall only be formed from the materials listed in Appendix 3.

Trapped volumes formed by riveting shall be eliminated at the design stage in accordance with Section 10 above.

14.4 Bearings and Sliding Joints

Designs for in-vacuum bearings and sliding joints for VQC 1 to 3 shall be subject to prior *acceptance* at the design stage. These should be eliminated by design wherever practical, for example by the use of flexure pivots. Solid (dry) lubricants or coatings are preferred, but other permitted lubricating materials are listed in Appendix 3.

In VQC 2 and 4 applications, polytetrafluoroethylene (PTFE) bearings are approved for positions where the predicted radiation fluence over the full operational life of ITER is less than 10^3 Gray (up to 10^6 Gray for *accepted* cross-linked PTFE) (Gamma or Neutron dose equivalents).

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 26 of 48

15 Windows and Window Assemblies

15.1 General

Window assemblies for VQC 1 and VQC 2 shall be double, with no 'design basis' common mode failure between the two windows, or shall be fitted behind a UHV isolation valve and have direct connection through the window to a VQC 3 vacuum system.

For windows transmitting high power (e.g. RF heating systems) the interspace pressure shall be continuously monitored and suitably interlocked with the power system.

Window assemblies accessible from outside the vacuum systems should incorporate mechanical protection against accidental impact.

For VQC 1A double window assemblies to air, the maximum diameter permitted is 160 mm.

An example of a specification for the design, qualification, manufacture and acceptance testing of window assemblies for use on ITER vacuum systems can be found in Appendix 6.

15.2 Qualification of Window Assemblies

Prior to manufacture, the design of window assemblies shall be qualified by performing type tests on pre-manufacture window assemblies. The *supplier* shall submit for *acceptance* a qualification test plan detailing the qualification tests to be performed in order to qualify the window for a particular application.

The qualification of the window assemblies for use on a vacuum boundary shall include the following tests:

- Pressure testing of window assemblies.
- Mechanical shock testing.
- Thermal shock testing.
- Helium leak testing.

15.3 Testing of Window Assemblies

Prior to the manufacture of window assemblies the *supplier* shall supply for *acceptance* a test plan and test procedures detailing the tests to be performed on window assemblies before delivery to the ITER site. After the completion of all manufacturing processes the window assemblies shall be subject to a thermal cycle test, pressure test, and helium leak test.

Acceptance testing of window assemblies which operate at elevated temperatures requires a minimum of three thermal cycles to be performed to their maximum operating temperature consistent with Section 25.5.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 27 of 48

16 Vacuum Valves and Valve Assemblies

For VQC 1, 2 & 3, valves shall be of all-metal construction with the exception of the valve closure seal, for which polyimide is also permitted.

For VQC 2 valves, elastomers may be used on the valve closure seal only with the prior *acceptance* of the ITER Vacuum RO.

For VQC 4, valves need not be all-metal except where they may be in contact with cryogenic fluids.

For VQC 1A all actuating and actuator bellows and seals shall be of double construction with the interspaces connected to the Service Vacuum System (see Section 11). Valves requiring compressed gas to maintain a seal shall be avoided where practical and any use requires prior *acceptance*.

Valve assemblies shall normally be installed such that the internal actuating system for the valve is on the side exposed to lower vacuum quality or to atmosphere and the seal face to the higher vacuum quality side. To facilitate this, all valve assemblies shall be permanently marked on the outside with an arrow pointing towards the seal face end of the assembly.

The valve position shall be positively identified by means of “open” and “closed” limit switches and a visual position indicator shall be provided on the valve or actuator body.

16.1 Acceptance Testing of Vacuum Valves and Valve Assemblies

Prior to shipping, valves shall be subject to an acceptance vacuum leak test. Detailed leak testing procedures shall be submitted for prior *acceptance*. Guidance can be found in Appendix 12.

Valve testing shall include the following helium leak tests:

- Valve body (global).
- Across the valve seat.
- Valve actuator bellows.
- Internal pressure element.
- Valve double bellows interspace.

Valves for use on VQC1 systems at elevated temperature shall be baked and hot leak tested at 200 °C.

An example specification for the design, manufacture and testing of valves for use on ITER vacuum systems is given in Appendix 7.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 28 of 48

17 Bellows and Flexibles

17.1 General

In general, bellows and flexibles are considered to be inherently vulnerable components (see section 9) due to their method of construction and because their application is typically to facilitate movement.

The use of bellows or flexibles in water circuits inside vacuum systems with any VQC shall be avoided by design wherever possible, and shall only be only permitted with prior *acceptance* for VQC 1A and VQC 2A when the surrounding vacuum is behind an isolation valve. For such usage, consideration must be made at the design stage to proven reliable performance in similar applications. Double bellows are not recommended for use in water circuits in vacuum.

In all test situations and after installation, the bellows shall be protected against all abnormal load conditions. This may include the design of physical constraints.

An example of a specification for the design, qualification, manufacture and acceptance testing of bellows assemblies for use on ITER vacuum systems can be found in Appendix 9.

17.2 Bellows Protection

Bellows shall be protected against damage from falling objects. The bellows protection shall be equivalent too, or better than, that provided by a cover of schedule 20 pipe.

17.3 Design of Bellows

Circular bellows are to be designed to the EJMA or EN14917 or equivalent. The use of other design codes is subject to *acceptance*. Where design codes are not applicable, design shall be by analysis and shall be proven by qualification.

Care shall be taken to ensure that the operational loading parameters are fully considered. Precautions need to be taken against rupture and other failure modes where there is a pressure difference in either direction between the inner and outer surfaces of the unit.

Bellows for use on VQC 1 systems shall be of double construction (or *accepted* multilayer design) with a monitored interspace, unless they are accessible for maintenance and fitted behind an approved interlocked isolating valve.

Where bellows are be used on VQC 2 systems it is recommended that they be of double construction (or *accepted* multilayer design) with a monitored interspace.

Multiple ply bellows are not permitted for VQC 1A components unless they are accessible for maintenance and fitted behind an approved isolating valve.

For VQC 1A and VQC 2A, where regular and significant movement is to be taken up by a double bellows, the norm shall be to design the double arrangement such that

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 29 of 48

one bellows is in compression whilst the other is in expansion so as to reduce the chances of a common mode failure.

The interspace between the two bellows of an assembly shall normally be filled with a suitable tracer gas and the pressure in the interspace shall be continuously monitored. The interspace shall be connected to the Service Vacuum System (see Section 11).

Normally accessible bellows assemblies and bellows assemblies which become accessible during machine maintenance shall be supplied with mechanical protection (such as the use of metal braiding or removable cover plates) to prevent accidental damage and ingress of matter to the bellows edge-welds or convolutions.

Non-circular bellows of non edge-welded construction are to be welded and then formed, rather than formed in parts then joined. This does not apply to the post-forming welding of bellows sections to collars. Cross welds are to be avoided where possible.

Hydrostatic, rolling or elastomeric formation is approved for all vacuum classes.

Bellows which are of edge-welded construction shall be acceptable provided that they comply with Section 7.1.

Cleaning of bellows shall be in accordance with the requirements of Section 24.

17.4 Qualification of Bellows

Bellows designed by analysis shall be subject to a qualification procedure prior to manufacture. The design of bellows shall be qualified by performing type tests on pre-manufacture bellows assemblies. The *supplier* shall submit for *acceptance* a qualification test plan detailing the qualification tests to be performed.

The qualification of the bellows assemblies shall include the following:

- Pressure test.
- Fatigue life test.
- Mechanical shock testing.
- Helium leak test.

17.5 Testing & Inspection of Bellows

Prior to the manufacture of bellows assemblies the *supplier* shall supply for *acceptance* a test plan and test procedure detailing the tests to be performed on bellows assemblies before delivery to the ITER site. After the completion of all manufacturing processes the bellows assemblies shall undergo a vacuum baking cycle to the operating temperature and a helium leak test. The *supplier* shall perform a survey of the bellows convolutions to confirm compliance with the bellows technical specification. The survey results shall be supplied to ITER and any non-conformance may lead to rejection of the bellows.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 30 of 48

17.6 Bellows Protection

Bellows shall be protected against damage from falling objects. The bellows protection shall be equivalent too, or better than, that provided by a cover of schedule 20 pipe.

18 Feedthroughs

18.1 General

Where for VQC 1A and 2A a feedthrough penetrating the air boundary is considered vulnerable (see Section 9) a doubly vacuum contained electrical feedthrough with interspace connected to the Service Vacuum System shall be used. Where necessary, alternative arrangements shown to ensure sufficient integrity of the feedthrough may be *accepted*.

The sheaths of mineral insulated cable shall not pass directly through a VQC 1A and 2A feedthrough, but shall be discontinuous and sealed within feedthrough interspaces.

Where applied or induced voltages may be present on such feedthroughs, then protection against arcing or Paschen breakdown shall be provided.

18.2 Paschen Breakdown

Where there is a risk that Paschen breakdown may occur in an interspace of a feedthrough, it must either be continually pumped or be backfilled with a gas of *accepted* composition to a pressure appropriate to mitigate the risk of Paschen breakdown.

In both cases, the interspace pressure must be continuously monitored and interlocked with the system controls to prevent power being applied in the event of single barrier failure.

19 Electrical Breaks

Where for VQC 1A and 2A, an electrical break (i.e. providing electrical isolation between systems) is considered vulnerable (see Section 9), a doubly vacuum contained electrical break with interspace connected to the Service Vacuum System shall be used, unless it is accessible for maintenance and fitted behind an approved interlocked isolating valve.

If an electrical break is at risk of Paschen breakdown in an external or internal rough vacuum, suitable precautions shall be taken to ensure that the risk of breakdown is eliminated.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 31 of 48

20 Cables for use in Vacuum

20.1 General

Up to 80 km of cables are anticipated in the ITER vacuum vessel. Many kilometres are also required in the cryostat. Special care shall be taken in the choice and quality control of such cables. In-vacuum cabling shall comply with all the general vacuum requirements for its VQC.

In particular:

- Materials shall be selected to be in accordance with Appendix 3.
- Outgassing shall be consistent with Table 20-1.

VQC	Outgassing temperature (°C)	Maximum steady state outgassing rate per unit length ⁺ [Pa.m ³ .s ⁻¹ .m ⁻¹]		Testing guidelines
		Hydrogen Isotopes	Impurities	
1	100	1 x 10 ⁻⁹	1 x 10 ⁻¹¹	Appendix 17
2 [‡]	20	1 x 10 ⁻⁹		Appendix 17
3	20	1 x 10 ⁻¹⁰		Appendix 17
4	20	1 x 10 ⁻⁹		Published data and conformity to clean work plan.
For VQC 2, 3 & 4 the total outgassing rate excludes water and hydrogen. *Valid for cables up to Ø 5mm outer sleeve. Pro-rata values can be applied for larger cables. ‡ The requirements for high voltage cables in the cryostat are still being studied and hence requirements will be specified in future.				

Table 20-1 – In vacuum cabling outgassing rates

Approved cable types pertaining to each VQC are listed in Appendix 10. The use of other cables is subject to prior *acceptance*.

All mineral insulated cables shall be sealed at both ends, and the void volume shall be less than 5%. The cable shall be proven to be leak tight, consistent with the levels for VQC 1 and VQC 2 given in Table 25-1, by helium bombing (see Appendix 12).

Specification for the manufacture and qualification of in-vacuum cables shall be *accepted* by the ITER Vacuum RO prior to production. A guide for the supply of in-vacuum cables can be found in Appendix 10.

20.2 Connectors and Terminations

In-vacuum connectors shall comply with the general vacuum requirements for the relevant VQC.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 32 of 48

21 Interconnection between VQC 1 systems

Any system which can be directly connected to the main ITER tokamak vacuum by opening a valve shall have, as a minimum, full range pressure monitoring. Residual gas analysis capability is also required for systems with volume > 1 m³.

The control of the isolating valve shall be via the ITER vacuum control system. Signals for all vacuum monitoring shall be made available to the ITER vacuum control system.

Any necessary inhibits on valve movements required to protect the sub-system, shall be made available to the ITER vacuum control system.

22 Proprietary Components

In the context of this Handbook, proprietary components are standard products which are listed in *supplier's* catalogues and are sufficiently well documented for their specification to be checked for fitness for purpose.

Proprietary components fully meeting the ITER specification of the item and the requirements of each VQC are permissible for use.

For VQC 1, 2 and 3, proprietary components meeting the requirements of this Handbook shall be supplied with an individual certificate of conformity, stating that the item conforms to the specification provided by the *supplier*.

For VQC 4, proprietary components shall be supplied with a certificate of conformity as above, but this may be in the form of generic or type conformance certificates to the catalogue specification.

A list of standard proprietary components which are known to conform to the requirements of this Handbook and so can be recommended for use on ITER vacuum systems is to be found in the Appendix 20.

Other proprietary components will be added to Appendix 20 when they are shown to meet the requirements of this Vacuum Handbook. Proposed additions should be submitted to the ITER Vacuum RO for consideration using the form in Appendix 20.

23 Vacuum Instrumentation

The requirements stated below shall be applicable to any instrumentation that directly interfaces with ITER vacuum spaces, and is applicable to all Vacuum Classifications.

In all cases instrumentation shall be compatible with ITER operational requirements and the ITER physical environment. This shall include among other matters:

- Being compatible with the relevant VQC.
- Being compatible with operation in a hydrogen environment.
- Exhibiting an outgassing rate consistent with those given in Section 5.4.
- Being leak tight consistent with Table 25-1.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 33 of 48

- Being resistant to neutron and gamma radiation at the instrument location. The radiation map to define these levels is defined in the ITER Room Book. See also Appendix 3.
- Being able to survive any pressure within the full operational and off-normal range (from 10^{-9} Pa to 0.15 MPa for VQC 1 and 2).

Instrumentation shall be servicing free to the maximum extent.

Generally on VQC 4, wherever the operational environment permits, active sensors may be used.

VQC 1 and 2 Instrumentation for use in the control of vacuum shall be fitted behind a UHV isolation valve or have agreed redundancy, and shall be accessible for maintenance.

24 Cleaning and Handling

24.1 Cleaning

Cleanliness is required during the whole manufacturing process and the preservation of cleanliness is good practice for any component to achieve the necessary vacuum standards and to minimise the time required to recover from any contamination incident. All components shall be subjected to a rigorous cleaning procedure, consistent with the Vacuum Classification of that particular component. A guide to cleaning and handling of components for use on ITER vacuum systems can be found in Appendix 13.

A detailed Clean Work Plan shall be submitted for prior *acceptance* to the ITER Vacuum RO before any cleaning operations are undertaken at the *supplier's* site. The plan shall specify how cleanliness will be maintained throughout the manufacturing process. It shall state when specific cleaning procedures will be applied and all of the controls which will be in place to maintain cleanliness, including handling.

Parts and sub-components shall be degreased using solvents or alkaline detergents, rinsed with demineralised water, and dried in hot gas or an oven to *accepted* procedures. The use of halogenated solvents is forbidden at any stage.

Lists of accepted cleaning fluids can be found in Appendix 4.

VQC 2 components incorporating cryostat vacuum-facing resins give a risk from volatile surface compounds which, if sticking to the reflective coatings of the tokamak thermal shields, could degrade the emissivity of the shields. As no acceptable procedure is foreseen for cleaning volatiles from a resin surface, care shall be taken not to introduce them to the surface.

24.2 Design Rules for Cleanability

At the design stage for a vacuum component, careful consideration shall be given to how the item is to be cleaned. In particular, crevices, blind holes, cracks, trapped volumes, etc., shall be avoided as these will act as dirt and solvent traps and it can

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 34 of 48

be very difficult to remove contaminants from such areas. Fortunately, good vacuum practice regarding trapped volumes will also usually result in a component which is cleanable.

24.3 Mechanical Processes on Vacuum Surfaces

Abrasive techniques to clean or to attempt to improve the appearance of the surfaces of vacuum components must be kept to an absolute minimum and are preferably avoided. For all VQC the use of files, harsh abrasives, sand, shot or dry bead blasting, polishing pastes and the like is prohibited under normal circumstances and may not be used without prior agreement. However, for VQC 2, shot or dry bead blasting is permitted. Stainless steel wire brushes, cleaned to the standards of this handbook, may be used only when it is considered essential to do so.

If grinding is essential on VQC 1 systems, the grinding wheel shall be free of organic components and shall have been manufactured in an oil-free, clean environment. The material and manufacturing process of the grinding wheel shall be *accepted* by the ITER Vacuum RO before use.

24.4 Pickling/passivation of Steels and Copper

If an assembly is pickled, then final machining of vacuum sealing surfaces must be left until after the pickling/passivation process.

Pickling should always be followed by passivation. This is best carried out chemically, although native oxide layers can reform on exposure to atmosphere. Pickling and passivation must always be followed immediately by an appropriate cleaning process relevant to the VQC of the component.

It should be noted that thermal outgassing from surfaces which have been pickled/passivated may well be greater than that from a native metal surface and baking may be required to reduce outgassing rates to acceptable levels prior to installation.

A guide to the pickling/passivation of steels and copper can be found in Appendix 14.

24.5 Post-Cleaning Handling of Vacuum Equipment

After final cleaning, the handling of vacuum equipment shall be strictly controlled to preserve cleanliness. General area cleanliness requirements pertaining to Vacuum Classifications are summarised in Table 24-1. The continuing suitability of any given area used for handling vacuum equipment should be checked on a regular basis by monitoring the airborne particulate count, which should not exceed 5×10^6 particles of size $> 0.5 \mu\text{m}$ per m^3 for VQC 1.

VQC	Cleanliness requirements	Personnel	Area Cleanliness	Monitoring
1	Segregated clean area. Limited Access to authorised personnel.	Trained personnel. Protective hair nets. Clean powder free	Daily Cleaning of area including floors	Daily air quality checks. Results stored

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 35 of 48

	Authorised equipment operated to approved procedures. Management of equipment (e.g. no vacuum pumps or other machinery exhausting into clean area).	latex or nitrile outer gloves. Clean white overalls. Overshoes. Clean job specific footwear.	and surfaces. Sticky mats at area entry.	in component document package. Weekly cleanliness test of area with results stored in component document package.
2	Authorised equipment operated to approved procedures. Management of equipment (e.g. no vacuum pumps or other machinery exhausting into clean area).	Trained personnel. Clean outer protective gloves for the handling of clean equipment.	Daily Cleaning of work area including floors and surfaces.	
3&4	House Keeping.	Trained personnel. Clean powder free latex or nitrile outer gloves for the handling of clean equipment.	Daily cleaning of area.	

Table 24-1 – Environmental cleanliness pertaining to VQC

Additional cleanliness requirements shall be defined in the component installation procedures.

Handling cleanliness guidelines for each VQC are detailed in Appendix 2.

24.6 Cleanliness during the Assembly of Vacuum Equipment

The mandatory requirements relating to cleanliness during assembly of vacuum equipment are detailed in Attachment 2 (ITER_D_MBXPP3).

25 Leak Testing

25.1 General

Generally, leak tests shall be performed:-

- During manufacturing to confirm the soundness of joining processes and sub-components and to reduce the risk of Incorporating leaks in a system that are subsequently difficult to locate or to repair.
- As an acceptance test at the *supplier's* site to show that completed assemblies meet the acceptance leak criteria.
- When a component arrives at the ITER site, to confirm that there has been no damage during packaging and transport. This test, which is under the

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 36 of 48

control and at the discretion of ITER, will be designed to be as simple and fast as possible.

- During installation, under the control of ITER, when testing is implemented to reduce the risk of newly made joint leaks only being detected at the completion of the total installation.
- On pumping down of the completed installation as part of the final commissioning.

Leak testing shall be carried out by suitably trained and experienced personnel. Acceptance test methods require prior *acceptance*. Guidance can be found in Appendix 12.

Leak testing shall be performed after pressure testing (if applicable). Before leak testing, components shall be cleaned, dried or baked in accordance with Section 27 of this Handbook.

Unless otherwise specified in the relevant contract or Procurement Arrangement the supply of any vacuum component shall include all testing jigs, flange closure plates (welded or otherwise) and fittings to allow helium leak testing at the ITER site. These may be the same items that were used for tests prior to delivery. Methodologies for the subsequent removal of such features shall also be supplied.

The requirement to leak test proprietary components delivered to the ITER site with a *supplier's* Certificate of Compliance may be waived by ITER at the discretion of the ITER Vacuum RO.

25.2 Maximum Acceptance Leak Rates

Maximum acceptance leak rates for several of the ITER vacuum systems are given in Table 25-1.

Any concession to permit leak rates greater than those specified in Table 25-1 can only be by prior *acceptance*.

25.3 Design Considerations for Leak Testing

All components and systems forming a vacuum boundary shall be designed so as to facilitate leak testing using tracer gas leak detection methods during the building of ITER.

Components shall also be designed to facilitate the timely localization of leaks occurring during ITER operations. Different techniques can be considered which may include the provision of small-bore tubing to allow the introduction of helium to the vicinity of potential leaks.

The design of vacuum systems shall be such that leak tightness can be proven across all vacuum boundaries.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 37 of 48

25.4 Scheduling of Leak Tests

Prior to manufacture the *supplier* shall have an *accepted* leak test plan detailing the timing and type of tests to be performed during manufacture. The plan shall include which tests are to be witnessed by the ITER or Domestic Agency Vacuum Specialist.

The ITER Vacuum RO shall be informed a minimum of two weeks in advance of a test requiring witnessing by ITER.

Scheduling of leak testing shall be in compliance with the ITER Leak Testing Policy (ITER_D_L5P5P2).

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 38 of 48

System/ Component	Maximum Leak Rate (Pa.m ³ /s air equivalent [†])
VQC 1 *	1×10^{-10}
VQC 2*	1×10^{-9}
VQC 3*	1×10^{-9}
VQC 4* (Atmosphere to insulation Vacuum)	1×10^{-7}
VQC 4* (Process line to insulation Vacuum)	1×10^{-10}
Tokamak primary vacuum (including all in-vessel components and attachments)	2×10^{-7}
Vacuum vessel (Including ports but excluding attachments) (Total allocation of leakage into main chamber vacuum)	1×10^{-7}
Individual vessel sector (Total allocation to a sector main chamber vacuum assuming enclosed)	1×10^{-8}
Individual field joints (covers port and sector field joints)	1×10^{-8}
Individual port plugs (complete)	5×10^{-10}
Each NB/DNB injector enclosure	1×10^{-8}
Cryostat vessel (excluding contents)	5×10^{-5}
Completed Cryostat (including all in-cryostat components and attachments) ‡	1×10^{-4}
Central solenoid assembly‡	1×10^{-7}
Individual PF-coil assembly‡	1×10^{-7}
Individual TF-coil assembly‡	1×10^{-7}
Complete thermal shield assembly‡	1×10^{-5}

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 39 of 48

*Individual system or component not otherwise mentioned.

† Helium equivalent Leak Rate (LR) = Air equivalent x 2.69 at the same temperature.

$$\frac{LR_{Helium}}{LR_{Air}} = \frac{\sqrt{M_{Air}}}{\sqrt{M_{Helium}}} = 2.69 \quad (M = \text{atomic mass})$$

‡ Values quoted refer to systems under normal operational pressures and temperatures. Conversion to room temperature and atmospheric pressure tests can be supplied on request.

Table 25-1 Maximum acceptance leak rates for various vacuum systems

Generally it is advised that component parts should be tested before assembly, but final assemblies must be tested before shipping to ITER. For VQC2A in the case of a construction with many joints which become embedded and inaccessible in an assembly, then individual leak tests may be *accepted* as an acceptance test to replace final assembly acceptance leak testing prior to shipping.

Leak testing may be performed at the ITER site following transportation of vacuum components prior to it being accepted by ITER for installation.

Installation leak testing will be carried out to *accepted* procedures as part of the ITER assembly. All ITER vacuum systems will undergo final leak testing as part of the integrated commissioning of the ITER machine.

25.5 Methods and Procedures

The leak test procedure for acceptance tests shall be *accepted* in advance by the ITER vacuum RO. The procedure shall describe how the leak test will be performed, and include configuration diagrams and full details of the equipment to be used. Guidance on acceptable methods of carrying out leak testing is given in Appendix 12.

The acceptance leak test method shall ensure leak tightness is proven across all vacuum boundaries.

Test conditions (pressure, temperature) for the acceptance leak test shall be as close as practical to the design conditions. Testing shall be carried out with the component at ambient temperature and as close as practical to both its maximum and minimum design temperatures. The direction of the pressure differential shall normally be in the same direction as during operation exhibited by the components. Exceptions will be considered for the larger ITER components for tests prior to the final commissioning tests.

Where acceptance leak tests are not to be performed on cryogenic systems at cryogenic temperatures, a method of cold leak testing any welded connections shall be *accepted* in advance.

For an acceptance helium leak test, the helium concentration around the test piece shall be at a minimum of 50% for the duration of the test. The helium concentration shall be measured and recorded. The helium shall be maintained for a period calculated to be sufficient to identify leaks at the acceptance level.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 40 of 48

Acceptance leak tests on VQC 1A or VQC 3A components which include joints of dissimilar materials² shall be subject to a minimum of three thermal cycles from ambient to the maximum possible operating temperature prior to leak testing. The time taken for any component to reach the specified bake temperature from ambient shall be less than 100 hours.

A representative of the ITER Organisation may inspect the *supplier's* leak testing equipment and witness a proof of procedure prior to the acceptance leak test.

Acceptance leak tests shall be witnessed or, where there are many tests agreed to form the acceptance leak testing, a representative sample of the test shall be witnessed. The ITER Vacuum RO shall nominate or approve the Vacuum Specialist to witness the acceptance leak tests. ITER may require that other key (ITER_D_L5P5P2) leak tests to be implemented as part of a manufacturing process be witnessed. Those tests to be witnessed by ITER, including the acceptance tests, shall be defined in the Manufacturing Inspection Plan (MIP).

25.6 Acceptance Leak Testing at the *Supplier's* Premises

The *supplier* is responsible for the supply of all testing equipment, vacuum components, all testing jigs, flange closure plates (welded or otherwise) and fittings to allow an acceptance helium leak test to be carried out.

No repair or re-work of the components (with the exception of simple tightening of flange joints or replacement of gaskets) shall be undertaken without prior agreement. Any repair or rework will require the leak test procedure to be repeated and may include a repeat leak test at the operating temperature.

No vacuum component which fails to meet the specified acceptance leak rate at the *supplier's* site shall be accepted for delivery to the ITER site without prior *acceptance*.

25.7 Acceptance Criteria for Leak Testing

On successful completion of the specified leak tests, the item under test may be accepted provided the following conditions have been met:

- The leak detector in the test configuration has been calibrated and its calibration value is within the limits of $\pm 5\%$ of the nominal value of the standard leak rate value, taking into account the ambient temperature and the age of the standard leak.
- The background level of the leak test was below the acceptance leak rate without electronic correction prior to the test.
- The reading from the leak detector has not increased in value above the measured background by more than the specified leak rate as defined for

² Metallic joints shall be considered to be of dissimilar materials if the difference in linear thermal expansion coefficients over the operating temperature range of the materials comprising the joint is greater than or equal to 20%. Joints between non-metallic materials shall be considered as dissimilar.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 41 of 48

the item under test throughout the entire duration of the leak test procedure.

- The test has been performed to the agreed procedure and, where specified in the Quality Plan, has been witnessed by the ITER Vacuum Specialist.

25.8 Acceptance Leak Testing at the ITER site

Normally, vacuum components shall be subject to a leak test at the ITER site following transportation. The purpose of such a test is to reduce the risk of installing a leaking component and is of particular importance for components which would have a high impact to replace or repair. This test will normally be performed by ITER but a *supplier* may witness this test. This test may be a more limited test than that performed at the *supplier's* site and may be performed at ambient temperature at the discretion of the ITER Vacuum RO.

25.9 Reporting of Leak Tests

Full records of the tests carried out shall be compiled in order to maintain traceability of the leak test history of a particular item. The records shall become part of the final document package for the component concerned. Records shall include the following:

- Data records of the output of the leak detector for all the global tests specified including the standard leak calibration and response time determination. These data records shall include the date and time of all the tests as well as any other data necessary to allow a full analysis of the results, such as the start and finish of helium gas application to the item under test.
- A record of the helium concentration during the leak test.
- A record of the system total pressure and temperature during a temperature cycle as it may pinpoint the time when a leak opened up and be instrumental in the subsequent diagnosis of the leak.
- The make and model of the helium mass spectrometer leak detector used in the test.
- The nominal value of all standard leaks used, their date of calibration, ageing and temperature characteristics, and the ambient temperature(s) experienced during the tests.
- Results of all tests showing whether it was a pass or fail and if a failure, the measured leak rate and the location of the leak plus the steps taken for repair or elimination.
- The magnitude and location (if applicable) of all leaks identified during testing. This includes leaks of size lower than the acceptance criteria for which no remedial action may have been taken.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 42 of 48

- A full record of any residual gas scans taken with appropriate time markers to identify the scans to the position in the component leak test cycle.

An example template for the reporting of leak tests is provided as part of Appendix 12

26 Baking

26.1 General

Vacuum components for the various classifications may require to be baked to ensure satisfactory vacuum performance. Raw materials may also require baking before being used in manufacture if a higher temperature is required to achieve satisfactory vacuum properties than will be possible later.

Baking can be included in the component leak testing procedure (see Section 25) and/or the component cleaning procedure (see Section 24). A bake temperature and duration will normally be specified in the specification documents and/or drawings for individual components or assemblies. If this is not the case, then the standard temperatures listed in Table 26-1 shall be used. Normally, the time taken for any component to reach the specified bake temperature from ambient shall be less than 100 hours and the component shall normally be held at the baking temperature for a minimum of 24 hours.

Where the *supplier* is unable to carry out a bake procedure, either to the standard conditions in Table 26-1 or as otherwise specified, then any variation shall be agreed with ITER before proceeding.

For all vacuum components that require baking, a detailed procedure describing the baking process shall be submitted for *acceptance* before any baking is started. The acceptable leak rate and vacuum conditions of any baking chamber shall be agreed as part of this procedure.

Vacuum ovens containing heating filaments within the vacuum are not permitted for VQC 1 baking operations without full qualification of the baking process.

Post bake handling of vacuum components shall be in accordance with Section 24.5.

A guide to the vacuum baking of components, including baking temperatures, is to be found in Appendix 15.

26.2 VQC 1 Components (non plasma-facing)

After manufacture, VQC 1 non plasma-facing components which operate at elevated temperature shall be baked using the guidance of Appendix 15. Baking shall be for a minimum of 24 hours at the maximum operating temperature. The bake cycle may be performed as part of the cleaning process or, if applicable, the hot leak test. There is no vacuum requirement to bake at temperatures in excess of the design temperature.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 43 of 48

26.3 VQC 1 Components (plasma-facing)

To ensure vacuum cleanliness and to reduce impurity outgassing, components which are plasma facing or operate within 0.25 m of plasma shall be conditioned after manufacture by vacuum baking following the guidance of the ITER Vacuum Handbook Appendix 15. For VQC 1 component materials in proximity to the plasma, the normal vacuum baking temperature is given in Table 26-1. Where the temperature is too high for a composite assembly, the component part requiring higher temperature baking shall be baked at that temperature prior to assembly and then the complete assembly baked at the lowest listed temperature of the component parts. Temperature requirements for baking materials not listed shall be agreed in advance of baking operations.

For any individual component, the point in the manufacturing schedule or testing procedure at which such bake or bakes is carried out and the maximum temperature used shall be agreed with the ITER Vacuum RO. Post baking handling shall be minimised to preserve cleanliness and shall be in accordance with Section 24.

Component Material	Baking temperature (°C) ¹
Beryllium	350 ²
Stainless Steel (all grades)	250
Carbon Composites	450 or 2000 ³
Precipitation-hardened copper alloys	250
Tungsten	350
¹ Maximum temperature for baking complete systems may be limited by the system components ² A 250 °C baking cycle for a substantially increased duration at may be permitted on approval. ³ Section 26.7 and Appendix 16	

Table 26-1 Baking temperature VQC 1 materials in proximity to the plasma

26.4 VQC 2 Components

There is normally no vacuum requirement to bake VQC 2 components, but baking may be used as part of the cleaning and surface conditioning process to achieve the outgassing requirements of Table 5-1.

26.5 VQC 3 Components

There is normally no vacuum requirement to bake VQC 3 components, but baking may be used as part of the cleaning and surface conditioning process to achieve the outgassing requirements of Table 5-1.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 44 of 48

26.6 VQC 4 Components

There is no vacuum requirement to bake VQC 4 components.

26.7 Vacuum Conditioning of Carbon Composites

In order to remove impurities from graphite or carbon fibre composite components (CFC), it is necessary to bake components in a suitable furnace. Due to the high temperature requirements of CFC, subcomponents shall be baked prior to system assembly.

Conditioning of CFC is dependent on the manufacturing processes involved; hence baking procedures must be qualified and *accepted* prior to manufacture.

After baking the total outgassing rate for Carbon Fibre Composites shall be $< 1 \times 10^{-6}$ Pa.m³.s⁻¹.m⁻³ at 200 °C (excluding the partial outgassing rates for H₂, CO and CO₂)

The *supplier* shall perform a degassing cycle of components after machining to a procedure approved by the ITER Vacuum RO in accordance with Section 26.

Guidance for the conditioning of CFC can be found in Appendix 16.

26.8 Documentation to be Supplied for Vacuum Baking

For each vacuum item, the following records shall be supplied:

- Record of the pre-baking conditioning cycle for the vacuum baking chamber.
- The initial leak rate of the vacuum baking chamber.
- The final leak rate of the vacuum baking chamber.
- A record of the temperature distribution for the item and the pressure within the vacuum item against time for the full duration of the bakeout process.
- A full record of any residual gas scans taken with appropriate time markers to identify the scans to the position in the component bakeout cycle.
- Full documentation regarding any leaks or any other problems which occurred during the baking and any remedial action taken.

27 Draining and Drying

27.1 Design Considerations for Draining and Drying

In order to perform effective vacuum leak testing systems under test must be dry.

VQC 1 in-vessel systems which contain water shall be designed in such away as to facilitate draining and drying. Systems shall be designed to be drained and dried so that after drying for <100 hours purge gas passing through the component has a water content <4000 ppm at ambient temperature and pressure.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date: 28 th May 2019	Page 45 of 48

Consideration shall be given to the position of inlet and outlet water feeds to minimise the volume of trapped water which cannot be removed without drying.

27.2 Components Delivered to ITER

Vacuum components delivered to the ITER site shall be dry internally and externally. Any internal volumes wetted during acceptance testing shall be drained completely and dried by purging with dry air until the purge gas has a water content of <4000 ppm (alternatively the system may be dried by baking using the guidance of Appendix 15 and backfilled with dry air). The volumes will then be left at atmospheric pressure of dry air for a minimum period of 24 hours at ambient temperature. If after that time, the water content of the enclosed gas has risen to >4000 ppm, the drying process shall be repeated until this condition is met.

28 Marking of Vacuum Equipment

Surfaces which are to be exposed to vacuum shall only be marked or identified if necessary and shall be marked by scribing with a clean sharp point, laser scribing or electromagnetic dot peen method. Seal faces shall not be marked in any way. For VQC1, chemical etching shall not be used unless *accepted* by the ITER Vacuum RO.

Only approved (appendix 4) dyes, marker pens, paints, etc. shall be used on surfaces which will be exposed to vacuum.

29 Packaging and Handling of Vacuum Equipment

Components shall be packed with adequate protection from thermal or mechanical stresses which may adversely affect the operation of the component. All packing shall be sealed and marked externally with the component VQC. Handling instructions shall also be clearly marked on the outside of the packaging. Chemical or radiological hazards, etc., shall be identified on the packaging. All such marking shall be in English and French.

All vacuum components shall be shipped dry internally and externally, irrespective of final acceptance testing at the *supplier's* site.

Aluminium foil is recommended for sealing pipe openings, and protective caps shall be fitted to flanges before packaging and sealing. Where it is not practical to enclose the components, e.g. due to size, all apertures must be sealed to prevent the ingress of contaminants during transit. Sealing surfaces shall be protected to prevent damage by scratching, impact, etc.

The use of adhesive tape for the protection and packaging of vacuum components shall be restricted to prevent the risk of contamination from the tape. In particular, tape used on austenitic stainless steel shall meet leachable chloride and fluoride limits of 15 ppm and 10 ppm, respectively. Where used, tape shall be fully removable leaving no residue, using isopropyl alcohol or acetone as the solvent to remove all traces of the adhesive.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 46 of 48

To prevent damage and possible contamination during transit, the packaging of components shall be done as soon as possible after acceptance testing and final cleaning at the *supplier's* premises. Cleaning and packaging operations may be witnessed by ITER.

Vacuum components shall be handled as little as possible after final cleaning. All subsequent operations shall be carried out in clean conditions consistent with Section 24.5.

In particular persons handling VQC 1 components shall wear clean powder-free latex or nitrile gloves (over cotton or linen gloves if desired) and, as a minimum, be dressed in clean white overalls. In the cases where the component is large (e.g. a vessel sector) and internal access is required, hair nets and clean overshoes over footwear specifically provided for use in the vacuum component shall be worn.

Volumes which have been pumped for leak testing shall be backfilled with dry nitrogen or air (<4000 ppm H₂O) at a positive pressure of 0.12 MPa and valved off. Where the equipment allows manned access, air shall always be used. Where this is not practical, alternative conditions shall be *accepted* by the vacuum RO.

Cryogenic volumes which have been previously filled with helium for testing shall also follow the above or may be backfilled with dry helium (<4000 ppm H₂O) at a positive pressure of 0.12 MPa and valved off.

Where practical, vacuum components shall be entirely enclosed in heat sealed polyethylene for shipping. The polyethylene enclosure shall be purged and backfilled with dry air (<4000 ppm H₂O). Where this is not practical, alternative conditions shall be *accepted* by the vacuum RO.

30 Incoming Inspection at ITER of Vacuum Equipment

Before acceptance by ITER all components delivered to the ITER site will be subject to incoming inspection.

The following inspections will normally be carried out on vacuum equipment delivered to ITER:

- Checking of backfilled volumes (see Section 29).
- Seal face inspection.
- Checking the integrity of packing and status of accelerometers (if fitted).
- Cleanliness check.
- Leak test.

On completion of the incoming inspection any non-conformance with, or deviation from, the vacuum specification or this Handbook shall be raised in accordance with Section 4.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 47 of 48

31 Long Term Storage of Vacuum Equipment

In many cases vacuum components will be delivered to the ITER site in advance of installation to the ITER vacuum system. Vacuum components shall be stored in such a state as not to degrade the vacuum performance.

In the case of VQC 1 components, after incoming inspection and acceptance, the components, where practical, shall be entirely enclosed in heat sealed polyethylene. The polyethylene enclosure shall be purged and backfilled with dry air (<4000 ppm water). Volumes which have been pumped for leak testing shall be backfilled with dry nitrogen (<4000 ppm water) at a positive pressure of 0.12 MPa and valved off. The component shall then be re-packed into its transportation case and stored at a suitable location.

After incoming inspection and acceptance VQC 2, 3 and 4 components shall be stored in clean, dry packing cases in a suitable location.

32 QA and Documentation

All vacuum components supplied to ITER shall be subject to the ITER Quality Assurance System detailed in the ITER Procurement Quality documentation (IDM Ref; ITER_D_22MFG4).

Specific guidance on satisfying the vacuum requirement of such a system is outlined in Appendix 19.

33 Acknowledgements

The ITER Vacuum Group acknowledges the following in the preparation of the ITER Vacuum Handbook:

UKAEA and JET, Culham Science Centre, Oxfordshire, UK

Accelerator Science and Technology Centre (ASTeC), Daresbury, UK

Dr. R J Reid, Dr. M Wykes and Dr. A Kaye

In addition the efforts of many in extensively reviewing the Handbook are acknowledged.

ITER Vacuum Handbook		
Revision: Issue 2.5	Date:28 th May 2019	Page 48 of 48

34 List of Attachments

1. Inspection and Qualification of Welded Vacuum Joints
2. Cleanliness Requirements Relating to the Assembly of Vacuum Equipment (ITER_D_MBXPP3)

35 List of Appendices

1. Base Pressures and Expected Pumping Speeds (ITER_D_2ELEJT).
2. Environmental Cleanliness Requirements pertaining to Vacuum Classification (ITER_D_2EL9Y6)
3. Accepted Materials (ITER_D_27Y4QC)
4. Accepted Fluids (ITER_D_2ELN8N)
5. *Acceptance* Checklist (ITER_D_2N4NDK)
6. Guide to the Supply of Windows (ITER_D_2DXZZ3)
7. Guide to the Supply of Valves (ITER_D_2EPFG4)
8. Supply and Manufacture of Vacuum Flanges (ITER_D_2DJYQA)
9. Guide to the Supply of Bellows (ITER_D_2E5LJA)
10. Supply and Manufacture of Cables for use in Vacuum (ITER_D_2ETNLM)
11. Standard Pipe Sizes (ITER_D_2E5PJK)
12. Guide to Leak Testing (ITER_D_2EYZ5F)
13. Guide to Cleaning and Cleanliness (ITER_D_2ELUQH)
14. Guide to Passivation and Pickling (ITER_D_2F547S)
15. Guide for Vacuum Baking (ITER_D_2DU65F)
16. Guide for the Conditioning of Graphite and Carbon Composites (ITER_D_27YH3U)
17. Guide to Outgassing Rates and their Measurement (ITER_D_2EXDST)
18. Vacuum Component Reliability Data (ITER_D_2F2PYS)
19. Guide Documentation and QA (ITER_D_2DMNNR)
20. Standard Components (ITER_D_2F9QWX)
21. Glossary of Vacuum Terms Relevant to ITER (ITER_D_2F94QX)



IDM UID

2EL9Y6

VERSION CREATED ON / VERSION / STATUS

02 Sep 2009 / 1.4 / Approved

EXTERNAL REFERENCE / VERSION

Baseline Report (not under Configuration Control)**Appendix 2 Environmental Cleanliness**

This Appendix provides guidelines relating to the cleanliness requirements for the post cleaning handling of vacuum components for installation in the various ITER Vacuum systems. It only refers to the post final cleaning cleanliness requirements to maintain the achieved cleanliness.

<i>Approval Process</i>			
<i>Author</i>	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
	Worth L.	02 Sep 2009:signed	IO/DG/COO/PED/FCED/VS
<i>Co-Authors</i>			
<i>Reviewers</i>			
<i>Approver</i>	Pearce R.	14 Sep 2009:approved	IO/DG/COO/PED/FCED/VS
<i>Document Security: Internal Use</i> <i>RO: Chiocchio Stefano</i>			
<i>Read Access</i>	GG: MAC Members and Experts, GG: STAC Members & Experts, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: EMAB, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: [CCS] CCS-All for Ext AM, LG: [CCS] CCS-Section Leaders, LG: [CCS] JACOBS, LG: [CCS] CCS-Doc Co...		

<i>Change Log</i>			
Appendix 2 Environmental Cleanliness (2EL9Y6)			
<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
v1.0	In Work	27 Aug 2008	
v1.1	In Work	12 Jan 2009	
v1.2	In Work	13 Jan 2009	
v1.3	Signed	18 Jun 2009	Updated to include new figures for airborne contamination and minor textual changes
v1.4	Approved	02 Sep 2009	Minor changes to text for consistency with Vacuum Handbook

ITER Vacuum Handbook : Appendix 2		
Revision: 1.4	Date: July 29 th , 2009	Page 1 of 3



ITER Vacuum Handbook Appendix 2

Environmental Cleanliness

	Name	Affiliation
Author/Editor	Liam Worth	Vacuum Group - CEP
Vacuum Responsible Officer	Robert Pearce	Vacuum Group - CEP

ITER Vacuum Handbook : Appendix 2

Revision: 1.4

Date: July 29th, 2009

Page 2 of 3

2 Environmental Cleanliness requirements pertaining to Vacuum Quality Classification

2.1 Scope

This Appendix provides guidelines relating to the cleanliness requirements for the post cleaning handling of vacuum components for installation in the various ITER Vacuum systems. It only refers to the post final cleaning cleanliness requirements to maintain the achieved cleanliness.

It is anticipated that further guidance which will not be mandatory may be provided in the future.

2.2 Post Cleaning Handling of Vacuum Components

The following details are reproduced from the ITER Vacuum Handbook (Issue 2.3), Section 24.5 and Table 24.1 and are therefore mandatory.

“After final cleaning, the handling of vacuum equipment shall be controlled to preserve cleanliness. General area cleanliness requirements pertaining to Vacuum Classification are summarised in Table 2-1. The suitability of any given area used for handling vacuum equipment should be assessed on a regular basis by monitoring the airborne particulate count and should not exceed 5.0×10^6 particles of size $> 0.5 \mu\text{m}$ per m^3 for VQC 1.

VQC	Cleanliness requirements	Personnel	Area Cleanliness	Monitoring
1	Segregated clean area. Limited Access to authorised personnel. Authorised equipment operated to approved procedures. Management of equipment (e.g. no vacuum pumps exhausting into clean area)	Trained personnel. Protective hair nets. Powder free latex or nitrile outer gloves. Clean white overalls. Overshoes. Clean job specific footwear	Daily Cleaning of area including floors and surfaces. Sticky mats at area entry	Daily air quality checks. Results stored in component document package. Weekly cleanliness test of area with results stored in component document package
2	Authorised equipment operated to approved procedures. Management of equipment (e.g. no vacuum pumps	Trained personnel Powder free latex or nitrile outer gloves for the handling of clean equipment	Daily Cleaning of work area including floors and surfaces.	

ITER Vacuum Handbook : Appendix 2

Revision: 1.4

Date: July 29th, 2009

Page 3 of 3

	exhausting into clean area)			
3&4	House Keeping	Trained personnel. Powder free latex or nitrile outer gloves for the handling of clean equipment	Daily cleaning of area.	

Table 2-1 Environmental cleanliness pertaining to VQC

Additional cleanliness requirements shall be defined in the component installation procedures.”



IDM UID

27Y4QC

VERSION CREATED ON / VERSION / STATUS

17 Jul 2017 / 1.20 / Approved

EXTERNAL REFERENCE / VERSION

Guideline (not under Configuration Control)**Appendix 3 Materials**

<i>Approval Process</i>			
	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
<i>Author</i>	Vine G.	17 Jul 2017:signed	IO/DG/COO/PED/FCED/VS
<i>Co-Authors</i>			
<i>Reviewers</i>	Pearce R.	31 Aug 2017:recommended	IO/DG/COO/PED/FCED/VS
	Worth L.	17 Jul 2017:recommended	IO/DG/COO/PED/FCED/VS
<i>Approver</i>	Lee G.- S.	08 Sep 2017:approved	IO/DG/COO
<i>#SecureIDM#</i>			
<i>RO: Chiocchio Stefano</i>			
<i>Read Access</i>	GG: MAC Members and Experts, GG: STAC Members & Experts, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: EMAB, AD: EUROfusion-DEMO, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: [CCS] CCS-All for Ext AM, LG: [CCS] CCS-Section Leaders, LG: [CCS] JACOBS,...		

<i>Change Log</i>			
Appendix 3 Materials (27Y4QC)			
<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
v1.0	In Work	27 Aug 2008	
v1.1	In Work	29 Aug 2008	
v1.2	In Work	12 Jan 2009	
v1.3	In Work	14 Jan 2009	
v1.4	Signed	26 Jan 2009	
v1.5	Signed	13 May 2009	
v1.6	Signed	18 Jun 2009	Changed approved to accepted throughout document
v1.7	Approved	02 Sep 2009	Minor textual changes for consistency with Vacuum Handbook
v1.8	Approved	26 Sep 2011	Reference to Material Approval Request form added. New materials added. References to requested materials added. Simplification to material groups. Changes agreed with ITER Vacuum RO prior to Up-load.
v1.9	Approved	11 Feb 2014	Added grade and standard for Alumina
v1.10	Approved	11 Feb 2014	Date correction. Affiliation modification.
v1.11	Signed	23 Jan 2015	Changes between v1.10 and v1.11 of 27Y4QC. Links added for, 304 B7 Outgassing data YDH 50 MAR XM-19 MAR Oxygen Free (OF) UNS C10200 Al-15 (Mirrors for EC Equatorial launcher) Tantalum sheet TiN Materials added:- Nitronic-60 (UNS S21800) 431 (UNS S43100) (1.4057) 431 (UNS S43100) (1.4059) Inconel 708 N-type thermocouple STEMET 1301 amorphous brazing alloy Nicuman 23 brazing alloy Nicuman 37 brazing alloy STEMET 1101 microcrystalline brazing alloy STEMET 1108 microcrystalline brazing alloy Aluminium Grade 6061 Tungsten Carbide Mechanical pump (sliding seal) Gold Thin leaf 100 micron (bonding agent) Silver-based braze BAg-8 Titanium ASTM Grade2 T2 & 5 T5 Silicon Mono-crystalline Silicon Poly –crystalline Diamond composite Skeleton-1 Glass Ceramic MACOR (MGC) Aluminum Oxide (TS-03312) Alumina Filled Cyanate Ester (MC7885-UF) Aluminium Nitride Shapal SH-15) Aluminium Nitride Shapal M-soft Aluminium Nitride (Circuit Board Substrate)

			Quartz Filled Cyanate Ester (MC7883-UF or MC9883-LPM) Kalrez Non-vacuum application (3rd party pump) Barium Fluoride vacuum windows Molybdenum (Tracks on surface of silicon wafer sensor) ZrO₂ with TiN coating Non-vacuum application (3rd party pump) ZrO₂ Non-vacuum application (3rd party pump)
v1.12	Approved	23 Jan 2015	Approval corrected to restricted for:- Aluminium Nitride (Shapal SH-15, Shapal M-soft, Circuit Board Substrate) Plus previous:- Links added for, 304 B7 Outgassing data YDH 50 MAR XM-19 MAR Oxygen Free (OF) UNS C10200 Al-15 (Mirrors for EC Equatorial launcher) Tantalum sheet TiN Materials added:- Nitronic-60 (UNS S21800) 431 (UNS S43100) (1.4057) 431 (UNS S43100) (1.4059) Inconel 708 N-type thermocouple STEMET 1301 amorphous brazing alloy Nicuman 23 brazing alloy Nicuman 37 brazing alloy STEMET 1101 microcrystalline brazing alloy STEMET 1108 microcrystalline brazing alloy Aluminium Grade 6061 Tungsten Carbide Mechanical pump (sliding seal) Gold Thin leaf 100 micron (bonding agent) Silver-based braze BAg-8 Titanium ASTM Grade2 T2 & 5 T5 Silicon Mono-crystalline Silicon Poly –crystalline Diamond composite Skeleton-1 Glass Ceramic MACOR (MGC) Aluminum Oxide (TS-03312) Alumina Filled Cyanate Ester (MC7885-UF) Aluminium Nitride Shapal SH-15) Aluminium Nitride Shapal M-soft Aluminium Nitride (Circuit Board Substrate) Quartz Filled Cyanate Ester (MC7883-UF or MC9883-LPM) Kalrez Non-vacuum application (3rd party pump) Barium Fluoride vacuum windows Molybdenum (Tracks on surface of silicon wafer sensor) ZrO₂ with TiN coating Non-vacuum application (3rd party pump) ZrO₂ Non-vacuum application (3rd party pump)
v1.13	Signed	23 Feb 2015	MAR ITER_D_9K3J5P for Alumimium 6061 use in VQC 2B and 4B now deleted as request is unnecessary. Use of Aluminium use in all VQC (except VQC 1A-restricted) is already indicated in Appendix 3 Table.
v1.14	Approved	25 Feb 2015	Materials:- -EPDM (Ethylene-propylene), & -Nitrile rubber (Buna – N) Added with use restricted to 2nd, outer, seal gasket only (i.e. between SVS pumped volume/Air) in VQC 2A double sealed flanges (1st, inner seal,

			being metallic) for consistency with materials noted in VH App 8, Flanges, Table 6.
			Aluminium "and alloys" noted in grades for clarity
v1.15	Approved	20 Aug 2015	Materials added Cu and Cu based alloys:- CuBe1.7 CuBe2 SeCu Ni and Ni based alloys:- Nilo 42 (Nickel Iron Alloy 42 material) Mineral cement:- Thermoguss 2000 Glass / Ceramic:- Zirconia ZrO2
v1.16	Approved	03 Nov 2015	Materials added:- Microbraz 10 Alloy BNi6 (Ni / P 11%) Molybdenum solid, pure (not powdered or compound)
v1.17	Approved	06 Jun 2016	Materials added:- PEEK shrink tubing, Brazing Filler Material (Ni 102 / BNi2 / L-Ni2 / B-Ni82CrSiBFE DuPont 951 Green Tape Shapal M-Soft NiP-11% electroless nickel braze Aluminium Nitride (W Coated) G11 / EPGC203 epoxy glass composite Magnesium Oxide, MgO, sintered
v1.18	Approved	12 Dec 2016	Materials added:- Polyimide-cable insulant Zirconia based ceramic paste (Resbond 940) Papyex: N 998 Flexible Graphite Inconel X-750 Aluminium alloy EN AW-6082-T6 Boron Carbide F4C Molybdenum alloy APT-3 TZM SA-240 316Ti Stainless steel Steel 316Ti (1.4571 according to VDEh)
v1.19	Signed	17 Jul 2017	Materials added:- Molybdenum Molykote D-321 R Anti-Friction Coating Sputtered MoS2 Brazing material NIORO AuNi 82/18% Araldite Rapid Ticuni Braze BrazeTec_CB10 Copper Alloy (Cu-Sn-Pb) Ertalon 66 SKTN-MED optical glue BPd-2 Braze
v1.20	Approved	17 Jul 2017	Materials added as previous version:-

			Molybdenum Molykote D-321 R Anti-Friction Coating Sputtered MoS2 Brazing material NIORO AuNi 82/18% Araldite Rapid Ticuni Braze BrazeTec_CB10 Copper Alloy (Cu-Sn-Pb) Ertalon 66 SKTN-MED optical glue BPd-2 Braze (& 1 correction-Nicrobraz 10 restored)
--	--	--	--

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 1 of 38

**ITER Vacuum Handbook
Appendix 3*****Accepted Materials***

	Name	Affiliation
Author/Editor	Liam Worth	IO Vacuum Section
Vacuum Responsible Officer	Robert Pearce	IO Vacuum Section

ITER Vacuum Handbook: Appendix 3		
Revision: 1.19	Date: July 17th, 2017	Page 2 of 38

3 ITER Approved Materials

3.1 Scope

This appendix relates to the materials *accepted* for use in ITER vacuum exposed to the ITER vacuum environments.

The ITER Vacuum Handbook (section 5.1) states that

“Only materials *accepted* by ITER for the relevant Vacuum Classification shall be used on ITER vacuum systems. All material for use in vacuum shall be clearly specified at the design stage and certified in accordance with EN 10204 2.2, 3.1 or 3.2, or equivalent, before being used in manufacturing.”

Pursuant to this, materials which may be used freely on vacuum systems with the Vacuum Classifications stated are listed in the tables below.

Materials listed in this Appendix and shown as being subject to restricted use for a particular Vacuum Classification are subject to either an overall quota or to particular restrictions on their position of use. *Acceptance* for any particular vacuum application of such a material shall be obtained by submitting the Material Approval Request Form, stored on IDM (ITER_D_2MGWR4), to the ITER Vacuum RO. An example of this form completed is to be found at the end of this Appendix.

3.2 Materials Not on the Approved List

Materials which are not on the *accepted* list may be proposed for use in vacuum. If the vacuum properties of the material are not sufficiently well documented for an assessment to be carried out, a programme of measurement of the relevant properties shall be agreed between the proposer and the designated ITER Vacuum RO.

Details of materials to be considered for *acceptance* shall be submitted to the ITER Vacuum RO using the Material Approval Request Form. The proposer shall agree in advance with the ITER Vacuum RO a plan detailing the type and method of testing to qualify the material for use. The Materials Approval Request Form along with the test data, report and supporting documentation, including any *supplier's* data (Certificates of Conformity, etc.), shall be submitted for consideration.

Materials qualified in this way may be added to the *accepted* list.

3.3 Material Selection / Qualification

The materials listed in the following tables have been considered in terms of usage (vapour pressure, outgassing etc) and in terms of the environment of intended use.

ITER Vacuum Handbook: Appendix 3		
Revision: 1.19	Date: July 17th, 2017	Page 3 of 38

The properties of materials may change either permanently or temporarily when irradiated. Such changes which can affect their suitability for use in vacuum may include -

- Induced radioactivity – which might necessitate the use of remote handling techniques to disassemble or remove a component (e.g. steels may become active). Induced activity may be long-lived or short-lived.
- Mechanical degradation – which might affect the physical integrity of a component or a bond between components or which may generate particulates which could spread through a vacuum system (e.g. PTFE degenerates to a powder). Such changes are permanent.
- Transmutation – where a particular atomic species with good vacuum properties is transformed into one with poor vacuum properties (e.g. silver transmutes to cadmium). The products formed by transmutation can themselves transmute hence such changes can not be considered permanent.
- Chemical change – where the material decomposes under the influence of radiation (e.g. Viton releases hydrochloric acid, and PTFE releases fluorine, both of which are undesirable). Such changes are permanent.
- Desorption – under the influence of radiation, many materials exhibit enhanced outgassing due to induced desorption (e.g. hydrogen from steel when irradiated with X-rays). This stops when the source of radiation is switched off.

The effect of irradiation has been considered for *accepted* materials, and shall be considered in the qualification when materials not on the list are assessed for inclusion on the list.

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 4 of 38

Table 3-1 *Accepted Materials*

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Austenitic stainless steels	316L, 316LN 316L(N)-IG + Corresponding EN grades	✓	✓	✓	✓	✓	✓	✓	✓
	316 + Corresponding EN grades	✗	✓	†	✓	†	✓	†	✓
	316Ti SA-240 (NB Bellows Convolutions) MAR: ITER_D_TT37NF			✓					

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 5 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	316Ti (Electrical and optical patch boxes) MAR: ITER_D_TLM3YP				✓				
	304L 304LN 304B4 + Corresponding EN grades	✓	✓	✓	✓	✓	✓	✓	✓
	304 304 B7 Outgassing data:- ITER_D_EMZ98G + Corresponding EN grades	✗	✓	†	✓	†	✓	†	✓
Austenitic stainless steels	YDH 50 MAR:- ITER_D_4CRYM8	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 6 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Austenitic Chromium-Manganese-Nickel stainless steels	XM-19 (UNS S20910), MAR:- ITER_D_DG7SKX JJ1	✓	✓	✓	✓	✓	✓	✓	✓
Austenitic Chromium-Manganese-Nickel stainless steels	Nitronic-60 (UNS S21800) MAR:- ITER_D_CA3TB6 Material data sheet ITER_D_CX9QCX Material information ITER_D_DCEREP	✓	✓	✓	✓	✓	✓	✓	✓
Precipitation Hardening Iron Base Super-alloy	Grade 660 (UNS S66286), another name A286 + Corresponding EN grades	✓	✓	✓	✓	✓	✓	✓	✓
Ferritic (martensitic) stainless steel	430 (UNS S43000) Eurofer, F82H, Rusfer,	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 7 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Ferritic (martensitic) stainless steel	431 (UNS S43100) (1.4057) ITER roughing pump shaft MAR:- ITER_D_DCCQYE Materials cert ITER_D_DBY4WW	x	x	x	x	†	†	x	x
Ferritic (martensitic) stainless steel	431 (UNS S43100) (1.4059) ITER roughing pump rotor and case MAR:- ITER_D_DCHJDM Materials cert ITER_D_DCEQ7B	x	x	x	x	†	†	x	x
Kovar	ASTM F15 KV-1~9	✓	✓	✓	✓	✓	✓	✓	✓
Nickel		✓	✓	✓	✓	✓	✓	✓	✓
Nickel based Alloys	Nimonic 80A(UNS N070080)	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 8 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Monel 400	✓	✓	✓	✓	✓	✓	✓	✓
	Alumel (95% Ni, 2% Mn, 2%Al, 1%Si)	✗	†	✗	✓	✗	✓	✗	✓
	Chromel (90%-10% Ni – Cr)	✓	✓	✓	✓	✓	✓	✓	✓
	Alloy 718 (UNS N07718) Alloy 625 (UNS N06625)	✓	✓	✓	✓	✓	✓	✓	✓
	Inconel 708 Bellows seal MAR:- ITER_D_KTP2JW	✓	✓	✓	✓	✓	✓	✓	✓
	N-type thermocouple MAR :- ITER_D_64J7S9	✗	✗	✗	✓	✗	✗	✗	✗
	Nilo 42 (Nickel Iron Alloy 42 material) MAR:- ITER_D_QTVQ7F	✗	✓	✗	✓	✗	✓	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 9 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Inconel X-750 (UNS N07750, DIN W.-Nr. 2.4669) MAR: ITER_D_S98EXM Material datasheet ITER_D_SM54DQ	✓	✓	✓	✓	✓	✓	✓	✓
Nickel based Braze	STEMET 1301 amorphous brazing alloy Vacuum brazing of W-Cu joint in the Divertor Dome PFUs armour (only PRPs) MAR:- ITER_D_7NTH2J Outgassing data:- ITER_D_7NSWW8 Mat Cert ITER_D_7NTH2J	✗	✓	✗	✓	✗	✓	✗	✓
	Nicrobraz 10 Alloy BNi6 (Ni / P 11%) Brazing of stainless steel cable sheaths into stainless steel bulkheads. MAR:- ITER_D_QZW8DY	✓	✓	✓	✓	✓	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 10 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Ni 102 Nickel-based high temp brazing paste For Brazing of non-vacuum boundary components DNB Beam (AKA:-Ni 102, BNi2, L-Ni2, B-Ni82CrSiBFE-970/1000, 4777F, 9500/97) MAR ITER_D_S43LCB	x	✓	x	✓	x	✓	x	✓
Nickel based Braze	Nickel - Phosphorus 11% vacuum braze for the 6x diamagnetic coils (55.AG) under Triangular Support MAR ITER_D_S5EHB2	x	✓	x	✓	x	✓	x	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 11 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Pure Copper	Oxygen Free (OF) UNS C10200 Oxygen Free electronic (OFE) UNS C10100 EU grades: Cu-ETP (CW004A), Cu-FRTP, (CW006A), Cu-OF (CW008A), Cu-OFE (CW009A), Cu-PHCE (CW022A)	†	✓	✓	✓	✓	✓	✓	✓
Pure Copper	Oxygen Free (OF) UNS C10200 OF (CW008A) MAR:- ITER_D_NT9JT5	†	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 12 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Copper alloys	CuCrZr-IG: Cr (0.6 – 0.9 %), Zr (0.07 – 0.15 %) CuCr1Zr (CW 106C) CuCrZr (UNS C18150) БрXLp (RF grade) YZC (JA grade)	✓	✓	✓	✓	✓	✓	✓	✓
	CuBe1.7 MAR:- ITER_D_RBENAP	✗	✓	✗	✗	✗	✗	✗	✗
	CuBe2 MAR:- ITER_D_RB34RC	✗	✓	✗	✗	✗	✗	✗	✗
	SeCu MAR:- ITER_D_R7NEZM	✗	✓	✗	✗	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 13 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Copper alloys- Bronze	Aluminum bronze: UNS C63200,(82Cu-9Al-5Ni4Fe), CuAl10Ni5Fe4 (CW307G) CW301G (CuAl6Si2Fe)	†	✓	✓	✓	✓	✓	✓	✓
Copper alloys- Bronze	Aluminium Bronze Casting (SO-5) (oilless bearing for in -vessel mirror motors. MAR:- ITER_D_4CT93S	✗	✓	✗	†	✗	†	✗	†
Copper alloys- Bronze	Bronze (Cu-Sn-Pb) Application is VQC N/A (approved for installation use only) MAR: ITER_D_UG2K5V								
Copper alloys- Alumina Dispersion Strengthened	Glidcop Al60 Glidcop Al25-IG Al-15	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 14 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Copper alloys- Alumina Dispersion Strengthened	Al-15 (Mirrors for EC Equatorial launcher) MAR:- ITER_D_4CQPLA	✗	✓	✗	✓	✗	✓	✗	✓
Copper-based braze	Nicuman 23 brazing alloy as a brazing alloy for use in the divertor MAR:- ITER_D_9K83MF Outgassing data:- ITER_D_6XLFJQ	✗	✓	✗	✗	✗	✗	✗	✗
Copper-based braze	Nicuman 37 brazing alloy for use in VQC 1B as a brazing alloy for use in the divertor. MAR :- ITER_D_9K6V2C Outgassing data:- ITER_D_6XLFJQ Materials cert ITER_D_9K6V2C	✗	✓	✗	✗	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 15 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Copper-based braze	STEMET 1101 microcrystalline brazing alloy Vacuum brazing of Cu-CuCrZr joint in the Dome PFUs armour MAR:- ITER_D_7NXAUN Outgassing data:- ITER_D_7NSWW8 Materials certificate ITER_D_7NSWW8	✗	✓	✗	✓	✗	✓	✗	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 16 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Copper-based braze	STEMET 1108 microcrystalline brazing alloy Vacuum brazing of Cu-CuCrZr joint in the Dome PFUs armour MAR:- ITER_D_7NSWW8 Outgassing data:- ITER_D_7NSWW8 Materials certificate ITER_D_7NSWW8	✗	✓	✗	✓	✗	✓	✗	✓
Beryllium	S – 65C VHP, DShG-200, TGP-56FW, CN-G01	✓	✓	✓	✓	✓	✓	✗	✗
Aluminium	Pure or alloys	†	✓	✓	✓	✓	✓	✓	✓
	Aluminium alloy EN AW-6082-T6 MAR : ITER_D_S97FXR Deviation request also required for this VQC 1A application	†							

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 17 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Tungsten	Pure sintered W and rolled, cast W alloy, W-1%La ₂ O ₃ CVD	✗	✓	✗	✓	✗	✓	✗	✓
Tungsten Carbide	WC Cemented Carbide (Bearing Ring). MAR:-ITER_D_4CSC86 Mechanical pump (sliding seal) MAR :- ITER_D_L25NLL	✗	✓	✗	✓	✗	✓	✗	✓
Caesium		✗	✓	✗	✓	✗	✓	✗	✓
Gold		†	†	†	✓	✓	✓	✓	✓
Gold	Thin leaf 100 micron (bonding agent) MAR:- ITER_D_QDASPX	✗	†	✗	✗	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 18 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Gold based braze	Nioro brazing materials (AuNi 82/18%) MAR: ITER_D_TVU72E	✓	✓	✓	✓	✓	✓	✓	✓
Silver		†	†	†	✓	✓	✓	✓	✓
Silver-based braze	BaAg-8 (Japanese Industrial Standard; JIS Z3261) Ag as filler material for brazing on the DNB bushing MAR :- ITER_D_AJL8YX Deviation request ITER_D_4AHGK6 Transmutation data ITER_D_4FJRHJ, ITER_D_7PGX7C	✗	†	✗	✗	✗	✗	✗	✗
Silver-based braze	BrazeTec_CB10 MAR: ITER_D_UMF87D		†						

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 19 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Silver-based braze	BPd-2 MAR: ITER_D_UXN7AY				†				
Tantalum	Sheet MAR:-ITER_D_2LN64R	✓	✓	✓	✓	✓	✓	✓	✓
Germanium		†	✓	†	✓	†	✓	†	✓
Samarium Cobalt (Sm ₂ Co ¹⁷)	R26HS	✗	✓	✗	✓	✗	✓	✗	✓
Zinc		✗	✗	✗	✗	✗	✗	✗	✗
Cadmium		✗	✗	✗	✗	✗	✗	✗	✗
Titanium	Pure or alloys	†	†	†	✓	†	✓	†	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 20 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Titanium	Titanium ASTM Grade2 T2 & 5 T5 ICH & CD antenna: Removable vacuum transmission lines MAR:- ITER_D_6R2ZJW Related attachments ITER_D_6R2ZJW, ITER_D_6R2ZJW, ITER_D_6R2ZJW	†	×	×	×	†	×	×	×
Titanium based braze	Ticuni Braze MAR: ITER_D_UMFFFP		†						
Quartz		✓	✓	✓	✓	✓	✓	✓	✓
Silicon	Mono-crystalline, 380 µm thick board Ex-vessel magnetic sensor (55.A5/A6 MEMS) Total mass ~2.5g for all sensors MAR:- ITER_D_DFVQ4C	×	×	×	†	×	×	×	×

KEY: ✓ = approved for use. × = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 21 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Silicon	Poly-crystalline 40 µm diameter plugs through 380 µm thick mono-Si circuit board Ex-vessel magnetic sensor (55.A5/A6 MEMS) Total mass ~0.001g (1mg) for all sensors MAR ITER_D_DG5JJR	✗	✗	✗	†	✗	✗	✗	✗
Silica,	Fused SiO ₂	✓	✓	✓	✓	✓	✓	✓	✓
Composite (diamond, silicon carbide, silicon)	Sckeleton-1 MAR:- ITER_D_64NG84	✗	✓	✗	✗	✗	✗	✗	✗
Diamond	Pure and DLC, CVD	✓	✓	✓	✓	✓	✓	✓	✓
Graphite	Pyrolytic (Langmuir Probe) MAR:- ITER_D_2LUWMJ	✗	†	✗	†	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 22 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
(see note 1)	GR-1 (restricted to allow tracking). MAR:- ITER_D_4CRPVS	✗	†	✗	†	✗	✗	✗	✗
	Papyex: N 998 Flexible Graphite MAR: ITER_D_KZWER7 Technical guide ITER_D_RZM4SU	✗	†	✗	✗	✗	✗	✗	✗
Composite (Carbon Fibre Composite CFC, see note 1)	SNECMA and Dunlop: various grades Supercarb NB 31 (3D), NIC-01 Toyo Tanso: CX2002U (2D)	✗	✓	✗	✓	✗	✓	✗	✓
Porcelain	C221	✓	✓	✓	✓	✓	✓	✓	✓
Ceramic	Kyocera A479	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 23 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Glass Ceramic	DuPont 951 Green Tape For Low-Temperature Co-fired Ceramics sensor applied to PBS 55.AA/AB/AC MAR ITER_D_S22ME4 Outgassing test reports ITER_D_QYRA8N ITER_D_QYM8ZD	x	✓	x	✓	x	✓	x	✓
	MACOR (MGC) Small machined parts MAR:- ITER_D_LF5RDE Vac data:- ITER_D_LEYH7S	x	✓	x	✓	x	✓	x	✓
	Shapal Hi-M SOFT (machinable AlN) In-vessel Magnetic Sensors (55.AA/AB/AC/AJ) applications Outgassing data ITER_D_C9TP4H Material datasheet ITER_D_C9XYVT	x	✓	x	✓	x	✓	x	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 24 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
MgAl ₂ O ₄		✓	✓	✓	✓	✓	✓	✓	✓
MgO	Magnesium oxide as base insulation material for the In-Vessel Coils conductor. Powder glued and sintered in blocks, confined in the conductor jacket MAR ITER_D_STESWL	✗	✓	✗	✓	✗	✓	✗	✓
Titanium dioxide TiO ₂		✗	✓	✗	✓	✗	✓	✗	✓
Alumina Al ₂ O ₃	Grade IV to ASTM D2442	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 25 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Alumina (Al ₂ O ₃)	Aluminum Oxide (TS-03312) Surface coating for slid pin, internal shield etc MAR:- ITER_D_4CQG7F	✗	✓	✗	✗	✗	✗	✗	✗
Alumina cyanate ester	Alumina Filled Cyanate Ester (MC7885-UF) Ex-vessel Magnetic Sensors (55.A5/A6 MEMS), Qty ~30g for all sensors MAR:- ITER_D_DFZ4YK	✗	✗	✗	✓	✗	✗	✗	✗
Aluminium Nitride	Shapal SH-15 (Small moulded/machined parts) MAR:- ITER_D_EH72BL	✗	†	✗	†	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 26 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Aluminium Nitride	Shapal M-soft (sintered composite of Al nitrate and B nitrate) MAR:- ITER_D_C9TCXH Outgassing data:- ITER_D_C9TP4H	x	†	x	†	x	x	x	x
Aluminium Nitride	Aluminium Nitride (Circuit Board Substrate) Ex-vessel sensor, total quantity 1.3kg maximum MAR:- ITER_D_DG7QJY Outgassing Data :- ITER_D_DG46FA	x	x	x	†	x	x	x	x
Aluminium Nitride	AIN (high purity sintered for IVS RF shield) MAR ITER_D_SMX5GR Outgassing data ITER_D_DG46FA Chemical analysis ITER_D_SLZRLQ	x	✓	x	✓	x	✓	x	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 27 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Silicon Nitride (SiN ₄)	TSN-03 (in vacuum ball brearing) MAR:- ITER_D_4C5QZJ	✗	✓	✗	✗	✗	✗	✗	✗
Caesium Iodide CsI	Ti activated	✗	✓	✗	✓	✗	✓	✗	✓
Resin -Epoxy	TGDDM	✗	✗	†	✓	†	✓	✗	✓
Resin -Epoxy	Araldite rapid MAR: ITER_D_UELUT4								✓
Resin -Cyanate Ester	Quartz Filled Cyanate Ester (MC7883-UF or MC9883-LPM) Bonding agent in sensor silicon wafer Ex-vessel Magnetic Sensors (55.A5/A6 MEMS), Qty ~30g for all sensors MAR:- ITER_D_DG4HDK	✗	✗	✗	†	✗	✗	✗	✗

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 28 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Optical glue	SKTN-MED optical glue MAR: ITER_D_76JZCP		†						
Composite (Epoxy / (glass fibre)	G10. Electrical insulator MAR:- ITER_D_4E9Q2M	x	x	x	✓	x	x	x	✓
	G11 / EPGC203. Electrical insulator MAR ITER_D_SRSGTV	x	x	x	x	x	x	x	✓
Inorganic adhesive	Thermoguss 2000	x	✓	†	✓	†	✓	x	✓
	Thermoguss 2000 MAR:- ITER_D_R69NWA Performance as a seal on MI cable must be demonstrated by qualification tests on actual cables	x	x	x	x	✓	x	x	x
Glass	S 2, R- and T	x	†	x	✓	x	✓	x	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 29 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Polyimide	Vespel	✗	✓	✗	✓	✗	✓	✗	✓
Polyimide	ERTALON 66 Application is VQC N/A (approved for installation use only) MAR: ITER_D_UG2BMP								
Polyimide	Thermoplastic Polyimide (TPI), Axon Cable MAR: ITER_D_RTNM3U This sample accepted by outgassing test in MAR				†				
PEEK (Polyether ether ketone)	As shrink tubing for steady-state sensors 55.A5/A6 MAR ITER_D_RT2T5V Product datasheet ITER_D_RMLNSM	✗	✗	✗	✓	✗	✓	✗	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 30 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
EPDM (Ethylene-propylene)	Use restricted to 2 nd , outer, seal gasket only (i.e. between SVS pumped volume/Air) in VQC 2A double sealed flanges (1 st , inner seal, being metallic)	✗	✗	†	✗	✗	✗	✗	✗
Nitrile rubber (Buna – N)	Use restricted to 2 nd , outer, seal gasket only (i.e. between SVS pumped volume/Air) in VQC 2A double sealed flanges (1 st , inner seal, being metallic)	✗	✗	†	✗	✗	✗	✗	✗
Superinsulation	Aluminium deposited Kapton, Mylar. Aluminium foil	✗	✗	✗	†	✗	✗	✗	✓
	Aluminium deposited Polyester	✗	✗	✗	✗	✗	✗	✗	†
Halogenated materials	PTFE, Fibreslip (Teflon fibre-glass weave)‡ ‡ PTFE bearings are approved for positions where the predicted radiation fluence over the full operational life of ITER is less than 103 Gray (Gamma or Neutron dose equivalents)	✗	✗	✗	✓	✗	✗	✓	✓

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 31 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Viton	x	x	†	†	†	✓	✓	✓
	Kalrez Non-vacuum application (3 rd party pump) VQC=N/A MAR:- ITER_D_L5MK2Q								
	Bromine (In Halogen lamp for CXRS Diagnostic in-situ calibration. MAR:- ITER_D_48D5EX	x	†	x	x	x	x	x	x
Barium Fluoride	Barium Fluoride vacuum windows MAR:- ITER_D_P8Q4NT ITER_D_32KTBX	✓	x	x	x	✓	x	x	x
Molybdenum	Molybdenum as solid pure form (i.e. not powdered or compound form)	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 32 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Molybdenum	Tracks on surface of silicon wafer sensor Ex-vessel Magnetic Sensors Qty ~0.001g (1mg) total for all sensors MAR:- ITER_D_DG5ZG5	✗	✗	✗	†	✗	✗	✗	✗
Molybdenum alloy	Mo alloy (Titanium(0.5)-Zirconium(0.08)- Molybdenum, TZM) MAR: ITER_D_TRZ5LS Outgassing data ITER_D_TR7YZC	✓	✓	✓	✓	✓	✓	✓	✓
MoS ₂	Molykote D-321 R Anti-Friction Coating MAR: ITER_D_U3HP3S								†
MoS ₂	Molykote D-321 R Anti-Friction Coating MAR: ITER_D_UAT6CB				†				

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 33 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
MoS ₂	Sputtered MoS ₂ MAR: ITER_D_TL5DS8		†						
MoS ₂		×	†	×		×	†	×	†
MoSe ₂		×	†	×	†	×	†	×	†
WS ₂		×	†	×	†	×	†	×	†
WSe ₂		×	†	×	†	×	†	×	†
Boron Nitride		×	✓	×	✓	×	✓	×	✓
Titanium Nitride (TiN)	PVD hard coating (anti-seizing of bolt threads, used generally) MAR:- ITER_D_2LPCE9	×	✓	×	✓	×	✓	×	✓

KEY: ✓ = approved for use. × = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 34 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Boron Carbide		x	†	x	†	x	†	x	†
	Boron Carbide, Hot pressed sintered MAR: ITER_D_T7DB99		†						
Zirconium Nitride	Chemical Vapour Deposition Coating	x	†	x	†	x	†	x	†
Zirconia	ZrO ₂ with TiN coating Non-vacuum application (3 rd party pump) VQC=N/A MAR:- ITER_D_L239S5								

KEY: ✓ = approved for use. x = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 35 of 38

Material / Material Class	Grades, (or composition applicable to ITER)	Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Zirconia	ZrO_2 ceramic can in a mechanical vacuum pump Non-vacuum application (3 rd party pump) VQC=N/A MAR :- ITER_D_KZAGJN								
	ZrO_2 sintered or plasma sprayed MAR:- ITER_D_R64Q62	✗	✓	✗	✗	✗	✗	✗	✗
	Zirconia based adhesive RESBOND 940. MAR & Outgassing data ITER_D_RUDVER :				†				

KEY: ✓ = approved for use. ✗ = not approved for use. † = restricted use

ITER Vacuum Handbook: Appendix 3		
Revision: 1.19	Date: July 17 th , 2017	Page 36 of 38

ITER Vacuum Handbook: Appendix 3

Revision: 1.19

Date: July 17th, 2017

Page 37 of 38

3.4 Example Material Request Form

<i>Material Approval Request</i> _(v1.0)					Ref No: Mat-Cha-1 <i>(Assigned by Vacuum RO)</i>				
Material submitted for approval:	Ceramic TRADE Name xxx								
Proposed form:	Solid								
Proposed Use:	HV Bushing								
VQC of proposed use :	1A	1B	2A	2B	3A	3B	4A	4B	N/A
	☒	☒	☒	☒	☒	☒	☒	☒	☐
If restricted give details of coverage (e.g. amount, surface area etc)									
Chemical Analysis / Material Safety Data Sheet available:	YES	Attached Copy document ref. (electronic if available)							
Agreed test plan:	NO	Attached Copy document ref. (electronic if available)							
Vacuum Test data Available:	YES	Attached Copy document ref. (electronic if available)							
Outgassing rate (at 100 °C)	N/A								
Vapour pressure (at 100 °C)	N/A								
Max temperature:	1000	Operating temperature:			240				
Pre installation treatment (baking, electropolishing etc)	Baked clean								
Requested by:	A.N.Other			Date Submitted:	25/03/09				
Affiliation :	USA			E-Mail	A.Other@USA.org				
Vacuum Material Approval Status: <i>(To be completed by ITER Vacuum Group RO)</i>									
Approved for VQC:	1A	1B	2A	2B	3A	3B	4A	4B	N/A
	☒	☒	☒	☒	☒	☒	☒	☒	☐
Limits / Restrictions (Attached Doc.) [†]									
ITER Vacuum RO	Approver:		L.Pressure						
	Date: 30/03/09								

Grey boxes to be completed by requesting officer. Boxes in Red to be completed by ITER Vacuum RO.

[†] Reasons for material rejections shall be supplied with the notification of material refusal.

ITER Vacuum Handbook: Appendix 3		
Revision: 1.19	Date: July 17 th , 2017	Page 38 of 38

3.5 Notes:-

1. Carbon and carbon composites shall be conditioned for (vacuum) use in accordance with the ITER Vacuum Handbook. ITER vacuum handbook ITER_D_29DFGH



IDM UID
2ELN8N

VERSION CREATED ON / VERSION / STATUS
17 Jul 2017 / 1.14 / Approved

EXTERNAL REFERENCE / VERSION

Guideline (not under Configuration Control)

Appendix 4 Accepted Fluids

<i>Approval Process</i>			
	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
<i>Author</i>	Vine G.	17 Jul 2017:signed	IO/DG/COO/PED/FCED/VS
<i>Co-Authors</i>			
<i>Reviewers</i>	Pearce R. Worth L.	31 Aug 2017:recommended 17 Jul 2017:recommended	IO/DG/COO/PED/FCED/VS IO/DG/COO/PED/FCED/VS
<i>Approver</i>	Lee G.- S.	08 Sep 2017:approved	IO/DG/COO
<i>#SecureIDM#</i>			
<i>RO: Chiocchio Stefano</i>			
<i>Read Access</i>	GG: MAC Members and Experts, GG: STAC Members & Experts, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: EMAB, AD: EUROfusion-DEMO, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: [CCS] CCS-All for Ext AM, LG: [CCS] CCS-Section Leaders, LG: [CCS] JACOBS,...		

Change Log

Appendix 4 Accepted Fluids (2ELN8N)

<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
v1.0	In Work	27 Aug 2008	
v1.1	In Work	12 Jan 2009	
v1.2	In Work	18 Jun 2009	Name change from approved to accepted. Cutting fluid removed.
v1.3	Approved	02 Sep 2009	Minor textual changes for consistency with Vacuum Handbook
v1.4	Approved	29 Feb 2012	New fluids added
v1.5	Approved	05 Oct 2012	Included new cutting fluid and approved liquid dye penetrant product families (with restrictions)
v1.6	Signed	26 Jan 2015	Fluids added:- Cutting fluids Blasocut Castrol SYNTILO 75 EF Cut1 - Carecut S cutting fluid Garia 2608 S-12 Green Star SINTOL Micro Jokisch Foam Cut Magicutsynth-g-60 QUAKER 3755 BIO Hocut 2000 SWISSCOOL 7722 Vasco 1045 Acids 20% Sulphuric Acid solution Concentrated Nitric Acid Hydrofluoric Acid LDP FluidLDP W divertor Couplants Babb Co matrix UT coupling agent CGM US Paste U49 Other Demin Water Elektrolyt EH01 Neutralix NG01
v1.7	Signed	10 Feb 2015	Fluids added:- Cutting fluids Blasocut Castrol SYNTILO 75 EF Cut1 - Carecut S cutting fluid Garia 2608 S-12 Green Star SINTOL Micro Jokisch Foam Cut Magicutsynth-g-60 QUAKER 3755 BIO

			Hocut 2000 SWISSCOOL 7722 Vasco 1045 Acids 20% Sulphuric Acid solution Concentrated Nitric Acid Hydroflouric Acid LDP FluidLDP W divertor Couplants Babb Co matrix UT coupling agent CGM US Paste U49 Other Demin Water Elektrolyt EH01 Neutralix NG01
v1.8	Approved	11 Feb 2015	Document version in header matched to IDM version Fluids added:- Cutting fluids Blasocut Castrol SYNTILO 75 EF Cut1 - Carecut S cutting fluid Garia 2608 S-12 Green Star SINTOL Micro Jokisch Foam Cut Magicutsynth-g-60 QUAKER 3755 BIO Hocut 2000 SWISSCOOL 7722 Vasco 1045 Acids 20% Sulphuric Acid solution Concentrated Nitric Acid Hydroflouric Acid LDP FluidLDP W divertor Couplants Babb Co matrix UT coupling agent CGM US Paste U49 Other Demin Water Elektrolyt EH01 Neutralix NG01
v1.9	Approved	19 May 2015	Fluids and other processing media added:- Cutting fluids:- Xtreme Cut 250

			Pickling and passivation:- Avesta Passivator 601 Avesta Cleaner 401 Avesta picking paste BlueOne TM 130 Markers:- Intrama SL.250 SL2100 Abrasive media:- Cutting wheel: Abratec TIPO 42 Cutting wheel: Sait "A30S" [Thk. 2 mm] Cutting wheel: Sait "XA24Q" [Thk. 3,2 mm] Cutting wheel: Sait "XA24Q" [Thk. 7 mm] Cutting wheel: Sait "XA46R" [Thk. 1,6 mm] Flapper wheel: Abratec LAMELLARE Flapper wheel: Abratec LAMELLARE Flapper wheel: Sait "SAITLAM UK 3A" Flapper wheel: S.L.F. Abrasivi LASER DISC Rough Wheel: Abratec TIPO 27 Rough Wheel: 3M "987C CUBITRON 2"
v1.10	Approved	19 Aug 2015	Temporary fixings incorporating adhesive tape added, all VQC N/A. 3M™ Aluminum Foil Tape 431 3M™ Preservation sealing Tape 481 Delvigo DVC 48040/7 A5 weld backing strip Delvigo DVC 44040/6 A5 weld backing strip Scapa 336 Aluminium adhesive tape For any use on higher VQC categories, verification of full cleaning process required on sample coupons
v1.11	Approved	05 Nov 2015	Fluids added to previous version:- Metalsierra DF Cutting fluid Stratomet Protective paint (for processing equipment-not vacuum components) HC 1100-Passivator. Cleansafe 787-Cleaning agent VK Jelly / VK Jelly – Power / VK Spray / VK Spray - 1000 -Pickling and passivation K-2 Jelly / K-2 Jelly – Power / K-2 Spray / K-2 Paste -Pickling and passivation Ultrasonic couplant, Rock Oil 09060 -Ultra Sonic Testing (UT) coupling fluid Dodecane, 297879, Sigma-Aldrich -Ultra Sonic Testing (UT) coupling fluid
v1.12	Approved	07 Jun 2016	Fluids added:- Blasocut BC 935 Kombi, cutting fluid Vasco 7000, cutting fluid HE 111 Electrolytic polisher, HC 1100-K3W1, passivator HC 500, cleaning agent HE 310 Electrolytic Polisher, DR60, as LDP remover, NGL 17.40 P, ultrasonic cleaning PROSOLV HP, solvent ALCATUM / ALCATUM HO, cleaning agent

			DOWCLEN 1601, cleaning agent Kool Mist Formula 78, machining coolant Oil Eater, degreaser Rebound 7, degreaser Trim E206, machining coolant Trim Tap Heavy, cutting fluid Trim Tap Light, cutting fluid Blasocut 4000, cutting fluid
v1.13	Approved	06 Dec 2016	Abrasives media added:- Klingspor KL 315 abrasive paper PMUC 10067 3M Roloc Disc 984F Abrasive disk 3M Cloth Belts 984F. Abrasive Belt for belt grinder 3M Cubitron™ II: Cut off Wheels 3M Flap Disc 967A. Lukas Tungsten carbide burrs. Stainless steel brush 3M XT-RD-Cleaning Disc Cleaning agent -Surtec®089 with Surtec®132 Cleaning agent -PROCIV CUP Cutting Fluid -Hocut 795 HX Cutting Fluid -SWISSCOOL 7722 Markers-Edding 750 white, Silver and Blue Pickling and passivation-PROCAP 137 Tape-3M 425 & 431 Aluminium Foil Tape Handling material-Kraitec Elastomer pad UT coupling fluids-MR 750 Ultrasonic Coupling Agent
v1.14	Approved	17 Jul 2017	Fluids / other process media added:- Paper KL361 grain 240, grain 120 and grain 80 ; Grinding tool RB Adhesive Technologies Glue Stick, Part #229 Tacky tape SM 5142 Cleaning fluid RBS826 CitriSurf 2310 Oemeta Novamet 100 Coolant SemiSyn-200 Blue Coolant S-787_Request_Fluid_Acceptance Castrol CareCut S 600 HOCUT 795 MP Hocut 795 H Blasocut BC 25 MD Pentagon Coolcut S Blasocut BC 35 Kombi MK-SOL Soluble metal working oil Synergy 915 APIEZON T Markal paint marker Edelstahlbeize Typ 14 AveryDennison HP MPI 2121 Tesa 4613 – Utility grade Duct Tape Soundclear 60 Soundclear 40 UT Couplant for ITER Cryostat

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 1 of 42

**ITER Vacuum Handbook
Appendix 4***Accepted Fluids*

	Name	Affiliation
Author/Editor	Liam Worth	Vacuum Group - CEP
Vacuum Responsible Officer	Robert Pearce	Vacuum Group - CEP

ITER Vacuum Handbook: Appendix 4		
Revision: 1.14	Date: 17 th July 2017	Page 2 of 42

4 ITER Accepted Fluids

4.1 Scope

This Appendix relates to fluids *accepted* to be used in the preparation and processing of materials and components which are exposed to the ITER vacuum environments, e.g. cutting fluids and cleaning solvents.

The ITER Vacuum Handbook (Section 6.1) states that

“Cutting fluids for use on VQC 1 and 3 systems shall be water soluble, non-halogenated and phosphorus and sulphur free”¹.

“*Accepted* cutting fluids for use in VQC 1 and 3 vacuum applications are listed in Appendix 4. The use of other cutting fluids requires prior *acceptance*.”

“*Acceptance* for the use of any particular non-approved cutting fluid shall be obtained by submitting the Fluid *Acceptance* Request Form, stored on IDM, to the ITER Vacuum Responsible Officer (RO).”

“For VQC 2 & 4 vacuum applications it is recommended that cutting fluids be water soluble, non-halogenated and phosphorus and sulphur free¹. They should be chosen from those listed in Appendix 4. Where this recommendation is not followed particular care shall be taken to ensure the appropriateness of the cleaning procedures”

The ITER Vacuum Handbook Section 24 states that

“Lists of *accepted* cleaning fluids can be found in Appendix 4”

Pursuant to this, materials which may be used freely for use on vacuum system items with the Vacuum Classifications stated are listed in the tables below.

4.2 Fluids not on the Accepted List

Fluids which are not on the *accepted* list may be proposed for use. If the vacuum related properties of the fluid are not sufficiently well documented for an assessment to be carried out, a programme of measurement of the relevant properties should be agreed between the proposer and the designated ITER Vacuum RO.

Details of fluids to be considered for *acceptance* should be submitted to the ITER Vacuum RO using the Fluid *Acceptance* Request Form. The proposer shall agree in advance with the ITER Vacuum RO a plan detailing the type and method of testing to qualify the material for use. The Fluid *Acceptance* Request Form along with the test data, report and supporting documentation, including any *supplier's* data (Certificates of Conformity, etc.), is to be submitted for consideration.

Fluids qualified in this way may be added to the *accepted* list.

¹ Sulphur, phosphorus and halogen (fluoride & chloride) content below 200 ppm for each.

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 3 of 42

A completed sample of the Fluid *Acceptance* Form is to be found at the end of this Appendix.

4.3 Fluid Selection / Qualification

The fluids listed in the following tables have been considered in terms of usage for vacuum purposes.

The properties of interest for this purpose include, *inter alia*,

- Fitness for purpose, i.e. how well it does the job for which it is used
- Easy and complete removal from the vacuum surface
- No induced degradation of the vacuum properties of the surface, e.g. increased outgassing
- No significant physical change to the surface
- Health and safety considerations

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 4 of 42

Fluids

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Cleaning fluids	Isopropyl Alcohol	✓	✓	✓	✓	✓	✓	✓	✓
	Ethyl Alcohol	✓	✓	✓	✓	✓	✓	✓	✓
	Acetone	✓	✓	✓	✓	✓	✓	✓	✓
	Axarel 9100 TM ,	✓	✓	✓	✓	✓	✓	✓	✓
	Citrinox TM	✓	✓	✓	✓	✓	✓	✓	✓
	P3 Almeco TM , P36 or T5161	✓	✓	✓	✓	✓	✓	✓	✓
	RBS 25	✓	✓	✓	✓	✓	✓	✓	✓
	RBS 35								

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 5 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	RBS A350	✓	✓	✓	✓	✓	✓	✓	✓
	Cleansafe 787 MAR: ITER_D_RWAQR3 Datasheet:- ITER_D_RWH2NT	✓	✓	✓	✓	✓	✓	✓	✓
	HC 500 Liquid cleaning agent (Used in electropolishing process for cryogenic piping for the pre-production cryopump) FAR ITER_D_RZ3F5Q SDS ITER_D_RZ7ZFP MDS ITER_D_RZJVUT Approved cleaning procedure ITER_D_S2FG8X	✓	✓	✓	✓	✓	✓	✓	✓
	NGL 17.40 P Precision Cleaning for Ultrasonic processes FAR ITER_D_SEW4QA	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 6 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	DOWCLEN [®] * 1601 Cleaning Fluid FAR ITER_D_STQSEK	✓	✓	✓	✓	✓	✓	✓	✓
	Oil Eater Manufacture of ITER-style vacuum flanges. FAR ITER_D_Q8DUKT SDS ITER_D_SRFUYV Cleaning Aqueous wash with Rebound 7 followed by DI water rinse	✓	✓	✓	✓	✓	✓	✓	✓
	CitriSurf 2310 MAR : ITER_D_UHXTT3	✓	✓	✓	✓	✓	✓	✓	✓
	RBS826 Cleaning fluid MAR : ITER_D_TF3G4P							✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 7 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Rebound 7 Manufacture of ITER-style vacuum flanges. Aqueous wash followed by DI water rinse FAR ITER_D_QCK53E SDS ITER_D_SRF2G7	✓	✓	✓	✓	✓	✓	✓	✓
	Surtec®089 with Surtec®132 FAR:- ITER_D_TTWQVK	✓	✓	✓	✓	✓	✓	✓	✓
	PROCIV CUP FAR ITER_D_STHJGP	✓	✓	✓	✓	✓	✓	✓	✓
Cutting fluids	Castrol CareCut S 125	✓	✓	✓	✓	✓	✓	✓	✓
	Vasco 1045	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 8 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Vasco 7000 MAR ITER_D_RFQND9 MDS ITER_D_RAW9TK Chemical Analysis ITER_D_RZBSEF SDS ITER_D_RF4MWR	✓	✓	✓	✓	✓	✓	✓	✓
	Alusol M-FX Only approved for use for the processing of base material which is subject to subsequent machining / cleaning operations utilising accepted water miscible fluids.	†	†	†	†	†	†	†	†
	Hocut 2000	✓	✓	✓	✓	✓	✓	✓	✓
	Hocut 795 HX Soluble Metalworking Oil FAR:- ITER_D_4H3QL6 Use accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 9 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Fluid Blasocut BC 35 Kombi SW ITER_D_HY3BCT	✓	✓	✓	✓	✗	✗	✗	✗
	Blasocut Kombi 935 MAR: ITER_D_RGD6JH Chemical analysis ITER_D_RZKU4T Safety datasheet ITER_D_=RGCLWS	✓	✓	✓	✓	✓	✓	✓	✓
	Blasocut 4000 Cleaning: Remove with water or solvent wipes FAR ITER_D_N54G6D	✗	✗	✓	✓	✓	✓	✓	✓
	CASTROL SYNTILO 75 EF ITER_D_PVM8M6	✓	✗	✗	✗	✗	✗	✗	✗
	Garia 2608 S-12 https://user.iter.org/?uid=LXQXBA Only for use on non-vacuum facing surfaces (which must be protected) and all surfaces cleaned post machining.	†	✗	†	✗	✗	✗	✗	✗

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 10 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Green Star SINTOL MICRO ITER_D_Q3N7N7	†	×	×	×	×	×	×	×
	Thread Cutting Oil Jokisch Foam Cut ITER_D_PNPSKN	†	†	†	†	†	†	†	†
	Magicutsynth-g-50 ITER_D_N3Q69Y	×	×	†	†	†	†	†	†
	QUAKER 3755 BIO ITER_D_NR4E2J	×	×	†	†	†	†	†	†
	Metalsierra DF Metalworking fluid FAR:- ITER_D_RMNBXQ Chemical analysis ITER_D_RMLNX3 Product data sheet ITER_D_RKLNT9 Safety data sheet ITER_D_RKLN7	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. × = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 11 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Cutting fluids	SWISSCOOL 7722 FAR: ITER_D_NFJ2N8 Approved for the spider application only	†	†	†	†	†	†	†	†
	SWISSCOOL 7722 FAR:- ITER_D_TTWU7X Use accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Xtreme Cut 250 MAR:- https://user.iter.org/?uid=QT8QGH Chemical analysis:- https://user.iter.org/?uid=QQ6LSM Subject to accepted cleaning procedure	✗	✗	✓	✓	✓	✓	✓	✓
	Hangsterfer's S787 Cutting Fluid MAR: ITER_D_SGMMPE				✓	✓	✓	✓	✓
	Castrol CareCut S 600 MAR: ITER_D_UCWFVD	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 12 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	HOCUT 795 MP MAR : ITER_D_TR7XRQ			✓	✓	✓	✓	✓	✓
	Hocut 795-H MAR : ITER_D_UDSBHL			✓	✓	✓	✓	✓	✓
	Blasocut BC 25 MD MAR : ITER_D_UFCFJC				✓	✓	✓	✓	✓
	Pentagon Coolcut S MAR : ITER_D_UJ8YF4			✓	✓	✓	✓	✓	✓
	Blasocut BC 35 Kombi MAR : ITER_D_U4EZRD	✓	✓	✓	✓	✓	✓	✓	✓
	MK_SOL_LUBE MAR : ITER_D_U4F3YE	✓	✓	✓	✓	✓	✓	✓	✓
	Hocut 795MP MAR : ITER_D_UVF5MT								

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 13 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Synergy 915 MAR : ITER_D_UXSKL9			✓	✓	✓	✓	✓	✓
	Trim Tap Heavy FAR ITER_D_N9XD58 SDS ITER_D_T3BGTK (manufacture of ITER-style vacuum flanges) Cleaning: Aqueous wash with Rebound 7 followed by DI water rinse	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 14 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Trim Tap Light FAR ITER_D_Q5UH9M SDS ITER_D_T3C35D (manufacture of ITER-style vacuum flanges) Cleaning: Aqueous wash with Rebound 7 followed by DI water rinse	✓	✓	✓	✓	✓	✓	✓	✓
Machining Coolant	Kool Mist Formula 78 (manufacture of ITER-style vacuum flanges) FAR ITER_D_RCAFRL SDS ITER_D_SYC4EU Cleaning: Aqueous wash with Rebound 7 followed by DI water rinse	✓	✓	✓	✓	✓	✓	✓	✓
	Oemeta Novamet 100 Coolant MAR : ITER_D_U8W2E5			✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 15 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	SemiSyn-200 Blue			✓	✓	✓	✓	✓	✓
	MAR : ITER_D_UVF66V								
	Trim E206 (manufacture of ITER-style vacuum flanges)								
	Cleaning: Aqueous wash with Rebound 7 followed by DI water rinse FAR ITER_D_RZEV86 SDS ITER_D_SZWMS6	✓	✓	✓	✓	✓	✓	✓	✓
Solvents	Nefras S2-80/120								
	Wiping of Dome divertor parts for degreasing after machining FAR ITER_D_JREV32	✓	✓	✓	✓	✓	✓	✓	✓
	PROSOLV HP								
	Degreasing of Copper & Tungsten for IVT Phase I FAR ITER_D_ST35B5	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 16 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Acids	Nitric acid (65%) FAR https://user.iter.org/?uid=PNAPTE https://user.iter.org/?uid=PNHPFU https://user.iter.org/?uid=PQA6AW	✓	✓	✓	✓	✓	✓	✓	✓
	Sulphuric Acid (20% solution) FAR https://user.iter.org/?uid=PJRKC5 https://user.iter.org/?uid=PK32SY https://user.iter.org/?uid=PKZE6A	✓	✓	✓	✓	✓	✓	✓	✓
	Nitric Acid Concentrated FAR https://user.iter.org/?uid=D29SZG https://user.iter.org/?uid=CZMVE5 https://user.iter.org/?uid=DBQPL9 https://user.iter.org/?uid=DBQPL9	†	†	†	†	†	†	†	†

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 17 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Acids	Hydrofluoric acid (in the manufacture of Divertor components prior to HIP) FAR https://user.iter.org/?uid=JQH3BW https://user.iter.org/?uid=JQH73T https://user.iter.org/?uid=JQHPUH	†	†	†	†	†	†	†	†
Alkaline solution	ALCATUM / ALCATUM HO Degreasing of Copper & Tungsten for IVT Phase I FAR ITER_D_STLR2W	✓	✓	✓	✓	✓	✓	✓	✓
Demin Water	Demin Water https://user.iter.org/?uid=N3PDHF	✓	✓	✓	✓	✓	✓	✓	✓
Etch and neutralise	Elektrolyt EH01 FAR https://user.iter.org/?uid=JEZ7DD	✓	✓	✓	✓	✗	✗	✗	✗
	Neutralix NG01 FAR https://user.iter.org/?uid=JF7ME6	†	†	†	†	†	†	†	†

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 18 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Lubricant	APIEZON Medium Temperature Approved for VQC N/A only MAR : ITER_D_TF84U8								
Pickling and passivation	Avesta Passivator 601 FAR:- https://user.iter.org/?uid=NVPBLQ Datasheets:- https://user.iter.org/?uid=NW5VLQ https://user.iter.org/?uid=P3WC76 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Avesta Cleaner 401 FAR:- https://user.iter.org/?uid=NSE9MN Datasheets:- https://user.iter.org/?uid=NSEM4 https://user.iter.org/?uid=NSH4DX Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 19 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Pickling and passivation	Avesta picking paste BlueOne TM 130 FAR:- https://user.iter.org/?uid=NQ4Y7N Datasheets:- https://user.iter.org/?uid=NQTMJC https://user.iter.org/?uid=NS77X8 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	HC 1100 Passivation solution for Stainless Steel (cryogenic piping for the pre-production cryopump) FAR:- ITER_D_RXJZB7 Datasheet :- ITER_D_RYMSKU	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 20 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	HC 1100-K3W1 Stainless steel passivator (cryogenic piping for the pre-production cryopump) FAR ITER_D_RZ5MBE MDS ITER_D_RZ7JP4 SDS ITER_D_RZK5GK Cleaning procedures ITER_D_S2FG8X to be used	✓	✓	✓	✓	✓	✓	✓	✓
	VK Jelly / VK Jelly – Power / VK Spray / VK Spray – 1000 FAR:- https://user.iter.org/?uid=RUGXSS			✓	✓	✓	✓	✓	✓
	Edelshahlbeize Typ 14 MAR : ITER_D_U7VKQS	✓	✓	✓	✓	✓	✓	✓	✓
	K-2 Jelly / K-2 Jelly – Power / K-2 Spray / K-2 Paste FAR:- ITER_D_RVVJ9S			✓	✓	✓	✓	✓	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 21 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	PROCAP 137 FAR:- ITER_D_STGBAW Use with approved cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
Liquid Dye Penetrant product families	Sherwin Inc. USA: NDT Europa BV: Developer: D100 Cleaner: DR62 Penetrant: DP51 <i>For VQC 1A/B This product is restricted and may only be used if component / system under test is subsequently baked at $T \geq 200$ °C for a minimum of 24 hours prior to vacuum leak testing.</i> <i>For VCQ2A, 3A& 4A this product may only be used to accepted procedures on the prior acceptance of a deviation request from the ITER Vacuum Handbook to cover the proposed area of use.</i>	†	†	†	✓	†	✓	†	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 22 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	DR60 as remover of dye penetrant FAR ITER_D_S7UXTC Accepted for this application on basis of post-use impregnation processes. Other uses will require approved cleaning process	x	x	✓	✓	x	x	x	x

KEY: ✓ = *accepted* for use. x = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 23 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	CGM CIGIEMME Developer : Rotrivel U (R2.82) 02011200 Cleaner: Velnet / Solnet (R2.60) 02011000 Penetrant: Rotvel Avio B (R2.72) 02021800 <i>For VQC 1A/B This product is restricted and may only be used if component / system under test is subsequently baked at $T \geq 200$ °C for a minimum of 24 hours prior to vacuum leak testing.</i> <i>For VCQ2A, 3A& 4A this product may only be used to accepted procedures on the prior acceptance of a deviation request from the ITER Vacuum Handbook to cover the proposed area of use.</i>	†	†	†	✓	†	✓	†	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † =accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 24 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	GS CHEM Co LTD Developer: DA (P101017D) Cleaner: RA (P101015C) Penetrant: PA (P101016P) <i>For VQC 1A/B This product is restricted and may only be used if component / system under test is subsequently baked at $T \geq 200$ °C for a minimum of 24 hours prior to vacuum leak testing.</i> <i>For VCQ2A, 3A& 4A this product may only be used to accepted procedures on the prior acceptance of a deviation request from the ITER Vacuum Handbook to cover the proposed area of use.</i>	†	†	†	✓	†	✓	†	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † =accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 25 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	EISHINKAGAKU corp. Japan Developer: R-1S (NT) Special Cleaner: R-1M (NT) Special Penetrant: R-1A (NT) Special <i>For VQC 1A/B This product is restricted and may only be used if component / system under test is subsequently baked at $T \geq 200$ °C for a minimum of 24 hours prior to vacuum leak testing.</i> <i>For VCQ2A, 3A& 4A this product may only be used to accepted procedures on the prior acceptance of a deviation request from the ITER Vacuum Handbook to cover the proposed area of use.</i>	†	†	†	✓	†	✓	†	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † =accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 26 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	MAGNAFLUX Dye penetrant testing of Tungsten monoblocks for ITER IVT https://user.iter.org/?uid=JP6EW8 Penetrant: Zyglo ZL-27A, fluorescent post emulsifiable penetrant Cleaner: Zyglo ZR-10C, hydrophilic remover Developer: Zyglo ZP-4B, dry powder developer Fluid to be removed by hot demineralised water rinse followed by baking.	†	†	†	†	†	†	†	†
Ultra Sonic Testing (UT) coupling fluids	Babb Co matrix UT coupling agent FAR https://user.iter.org/?uid=PTZ2WR https://user.iter.org/?uid=PUW2LU Part to be cleaned to an accepted procedure after UT	†	†	†	†	†	†	†	†
	CGM US Paste U49 FAR https://user.iter.org/?uid=PUXQHP https://user.iter.org/?uid=PVAE22 Remove residues with clean cloth and acetone.	†	†	†	†	†	†	†	†

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 27 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Ultra-Sonic Testing (UT) coupling fluids	09060, Rock Oil, Vacuum test data https://user.iter.org/?uid=RRAZ87 ITER_D_RMSL86	✓	✓	✓	✓	✓	✓	✓	✓
	Dodecane, 297879, Sigma-Aldrich Vacuum test data ITER_D_RRAZ87 ITER_D_RMSL86	✓	✓	✓	✓	✓	✓	✓	✓
	Soundclear Grade 60 MAR : ITER_D_U2WF3L (can be recommended for use as component is baked)	✓	✓	✓	✓	✓	✓	✓	✓
	Soundclear Grade 40 MAR : ITER_D_U348TX (can be recommended for use as component is baked)	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 28 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Pentagon Ultra 30 for use as UT couplant (approved for this application only, on basis of post –use surface removal by machining) MAR : ITER_D_UVC2BJ			✓					
	MR 750 Ultrasonic Coupling Agent FAR:- ITER_D_TX5XPV Cleaning as per ITER approved procedure document no. ITER CR-LTTS-602.	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 29 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Markers	Intrama SL.250 SL2100 MAR https://user.iter.org/?uid=QZSP86 Outgassing test report_MarkerPen_Intrama.SL.250 https://user.iter.org/?uid=QXVLSU Outgassing test report_MarkerPen_Intrama.SL.2100 https://user.iter.org/?uid=QXM5QJ Material acceptance report https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓					
	Markal Certified Valve Action Paint Marker MAR : ITER_D_UBF44E (Certified for <200ppm halogen - agreed but should not be used on thin wall boundaries with material < 1.5mm.)			✓	✓				

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 30 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Edding 750 White, Silver & Blue FAR:- ITER_D_AFEQ97 Cleaning as per approved procedure ; ITER-CR-LTTS-602			✓	✓	✓	✓	✓	✓
Protective paint (on material processing equipment)	Stratomet Protective paint FAR:- ITER_D_R7TFB7 Chemical analysis:- ITER_D_R6CD9Z Safety data sheet:- ITER_D_R6CCRZ	✓	✓	✓	✓	✓	✓	✓	✓
Abrasive media	Cutting wheel Abratec TIPO 42 MAR:- https://user.iter.org/?uid=QZRF3E Outgassing report :- https://user.iter.org/?uid=GGREMQ Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 31 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Cutting wheel: Sait "A30S" [Thk. 2 mm] MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Cutting wheel: Sait "XA24Q" [Thk. 3,2 mm] MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 32 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Cutting wheel: Sait "XA24Q" [Thk. 7 mm] MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Cutting wheel: Sait "XA46R" [Thk. 1,6 mm] MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Flapper wheel: Abratec LAMELLARE MAR:- https://user.iter.org/?uid=QZRF3E Outgassing report:- https://user.iter.org/?uid=GJ584M Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = accepted for use. ✗ = not accepted for use. † = accepted for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 33 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Flapper wheel: Sait "SAITLAM UK 3A" MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Flapper wheel; S.L.F. Abrasivi LASER DISC – "SERIE 10-ALU DISC" MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Rough Wheel: Abratec TIPO 27 MAR:- https://user.iter.org/?uid=QZRF3E Outgassing report ; - https://user.iter.org/?uid=HD5Z3U Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 34 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Rough Wheel: 3M “987C CUBITRON 2” MAR:- https://user.iter.org/?uid=QURJQL Outgassing report:- https://user.iter.org/?uid=HK7F54 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	Klingspor KL 361 Abrasive paper. PMUC 10067 FAR:- ITER_D_TXD2ZJ Cleaning with alcohol after usage	✓	✓	✓	✓	✓	✓	✓	✓
	3M Roloc Disc 984F Abrasive Disc FAR:- ITER_D_4H8PDW Area to be cleaned with solvent after processing	✓	✓	✓	✓	✓	✓	✓	✓
	3M Cloth Belts 984F Abrasive Belt for belt grinder FAR:- ITER_D_4HBVE3 Must be followed by cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 35 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	3M™ Abrasive Products, High Performance Cut off Wheels, Depressed Center Grinding Wheels, Grind Wheels Type 27, Cubitron™ II FAR:- ITER_D_4HD79D Must be followed by cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓
	3M Flap Disc 967A Flap disc FAR:- ITER_D_T79GNQ Area to be cleaned with solvent after operations with flapper	✓	✓	✓	✓	✓	✓	✓	✓
	3M XT-RD-Cleaning Disc FAR:- ITER_D_4H3ZHJ Must be followed by cleaning with solvent	✓	✓	✓	✓	✓	✓	✓	✓
	Tungsten carbide burrs Lukas Abrasive Pencil FAR:- ITER_D_T8FBAG	✓	✓	✓	✓	✓	✓	✓	✓
	Stainless steel brush FAR:- ITER_D_T8FUKG	✓	✓	✓	✓	✓	✓	✓	✓
	Paper KL361 grain 240, grain 120 and grain 80 ; Grinding tool RB 317 LX-R grain 80 FAR : ITER_D_UAMCD5	✓							

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 36 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Tetrabor lapping paste (water/polyalcohol based) FAR:- https://user.iter.org/?uid=QF6X54 Datasheets:- Safety https://user.iter.org/?uid=QED2DQ https://user.iter.org/?uid=QEJ42W https://user.iter.org/?uid=QERFGW https://user.iter.org/?uid=QF2HJZ https://user.iter.org/?uid=QEH9AG https://user.iter.org/?uid=QF7K99 Subject to accepted cleaning procedure	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 37 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	HE 111 Electrolytic polisher (cryogenic piping for the pre-production cryopump) FAR ITER_D_RN4QKV Cleaning procedures ITER_D_S2FG8X to be used SDS ITER_D_RN6FUA	✓	✓	✓	✓	✓	✓	✓	✓
	HE 310 Electrolytic Polisher (cryogenic piping for the pre-production cryopump) FAR ITER_D_RYS3HQ SDS ITER_D_RYTRXG Cleaning procedures ITER_D_S2FG8X to be used	✓	✓	✓	✓	✓	✓	✓	✓

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 38 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Adhesive tapes	3M™ Aluminum Foil Tape 431 FAR:- ITER_D_R23U88 For use on VQC N/A surfaces only with solvent clean. Before use on higher VQC categories, verification of full cleaning process cleaning required on sample coupons								
	3M™ Preservation sealing Tape 481 FAR:- ITER_D_R24JEX For use on VQC N/A surfaces only with solvent clean. Before use on higher VQC categories, verification of full cleaning process cleaning required on sample coupons								

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 39 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
Adhesive tapes	Delvigo DVC 48040/7 A5 weld backing strip FAR:- ITER_D_R477ZK For use on VQC N/A surfaces only with solvent clean. Before use on higher VQC categories, verification of full cleaning process cleaning required on sample coupons								
	Delvigo DVC 44040/6 A5 weld backing strip FAR:- ITER_D_R25TST For use on VQC N/A surfaces only with solvent clean. Before use on higher VQC categories, verification of full cleaning process cleaning required on sample coupons								

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 40 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	Scapa 336 Aluminium adhesive tape FAR:- ITER_D_R4AZFV For use on VQC N/A surfaces only with solvent clean. Before use on higher VQC categories, verification of full cleaning process cleaning required on sample coupons								
	AveryDennison HP MPI 2121 MAR : ITER_D_UDWANR (Recommended as component is cleaned and baked after use)	✓							
	Tesa 4613 – Utility grade Duct Tape (use of cryostat) MAR : ITER_D_UPXQCQ (Ok for VQC 2 but avoid to use on thin walled bellows or lips <1.5 mm thick)			✓					

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 41 of 42

Type	Name / type	Applicable to Vacuum Quality Classification							
		1A	1B	2A	2B	3A	3B	4A	4B
	3M 425 & 431 Aluminium Foil Tape FAR: ITER_D_U33P6M			✓	✓	✓	✓	✓	✓
Handling / transport materials	Kraitec anti-slip elastomer pads FAR:- ITER_D_4GRXXK	✓	✓	✓	✓	✓	✓	✓	✓
Adhesives	Adhesive Technologies Glue Stick, Part 229 MAR : ITER_D_UHDX7N (glue pucks for laser tracking to tie plate)			✓	✓				
	TACKY TAPE SM5142 (vacuum bag tape sealant) MAR : ITER_D_TX66XF			✓					

KEY: ✓ = *accepted* for use. ✗ = not *accepted* for use. † = *accepted* for restricted use only

ITER Vacuum Handbook: Appendix 4

Revision: 1.14

Date: 17th July 2017

Page 42 of 42

<i>Request for Acceptance of Fluid</i>						Ref No: fluid-01 (Assigned by Vacuum RO)			
Fluid submitted for <i>acceptance</i> :		Cut ace 123							
Proposed Use:		Metal Cutting fluid							
VQC of proposed use:		1A	1B	2A	2B	3A	3B	4A	4B
		✓							
Chemical Composition / suppliers data sheet		Yes	Attached Copy (electronic if available)						
Agreed test plan:		No	Attached Copy (electronic if available)						
Vacuum Test data Available:		Yes	Attached Copy (electronic if available)						
Solubility in water (at ambient temperature)									
Cleaning method (if applicable)		Rinse in de mineralised water							
Vapour pressure (at 100 °C)		No	Pa						
Supporting information		Evaporates in air leaving oily residue							
Requested by	L.Pressure			Date Submitted		29/07/08			
Affiliation:	US DA			E-Mail	L.Pressure@iter.org				
Fluid Acceptance Status: (<i>To be completes by ITER Vacuum Group RO</i>)									
Acceptance for VQC:		1A	1B	2A	2B	3A	3B	4A	4B
		✓	✓	✓	✓	✓	✓	✓	✓
Limits / Restrictions (Attached Doc.)		Fluid to be removed by hot demineralised water rinse (Cut ace 123 .doc IDM Ref 15R8UI)							
ITER Vacuum RO		Acceptor:		H.M. Self					
		Date: 09/08/08							

Grey boxes to be completed by requesting officer. Boxes in Red to be completed by ITER Vacuum RO.



IDM UID

2EYZ5F

VERSION CREATED ON / VERSION / STATUS

16 Sep 2009 / 1.4 / Approved

EXTERNAL REFERENCE / VERSION

Guideline (not under Configuration Control)**Appendix 12 Leak Testing**

<i>Approval Process</i>			
	<i>Name</i>	<i>Action</i>	<i>Affiliation</i>
<i>Author</i>	Worth L.	16 Sep 2009:signed	IO/DG/COO/PED/FCED/VS
<i>Co-Authors</i>			
<i>Reviewers</i>			
<i>Approver</i>	Pearce R.	16 Sep 2009:approved	IO/DG/COO/PED/FCED/VS
<i>Document Security: Internal Use</i> <i>RO: Chiocchio Stefano</i>			
<i>Read Access</i>	GG: MAC Members and Experts, GG: STAC Members & Experts, AD: ITER, AD: External Collaborators, AD: IO_Director-General, AD: EMAB, AD: Auditors, AD: ITER Management Assessor, project administrator, RO, LG: [CCS] CCS-All for Ext AM, LG: [CCS] CCS-Section Leaders, LG: [CCS] JACOBS, LG: [CCS] CCS-Doc Co...		

<i>Change Log</i>			
Appendix 12 Leak Testing (2EYZ5F)			
<i>Version</i>	<i>Latest Status</i>	<i>Issue Date</i>	<i>Description of Change</i>
v1.0	In Work	27 Aug 2008	
v1.1	In Work	22 Sep 2008	
v1.2	In Work	12 Jan 2009	
v1.3	Approved	18 Jun 2009	Changed approved to accepted
v1.4	Approved	16 Sep 2009	Maximum detectable leak rate changed from 0.1Mpa.m3.s-1 to 100Pa.m3.s-1

ITER Vacuum Handbook : Appendix 12

Revision: 1.4

Date: September 16th, 2009

Page 1 of 16

**ITER Vacuum Handbook
Appendix 12****Guide to Leak Testing of Components for the ITER
Project**

	Name	Affiliation
Author/Editor	Liam Worth	Vacuum Group - CEP
Vacuum Responsible Officer	Robert Pearce	Vacuum Group - CEP

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 2 of 16

12	Vacuum Leak Tightness and Testing.....	4
12.1	Scope and Status.....	4
12.2	General	4
12.3	Leak testing Methodologies.....	5
12.3.1	Over Pressure Methods	5
12.3.1.1	Mass Spectrometer Sniffing Probe	5
12.3.1.2	Probe leak testing (vacuum box or suction cup method).....	5
12.3.1.3	Pressurisation – evacuation (“bombing”) test.....	6
12.3.2	Vacuum Leak Detection Methods	6
12.3.2.1	Pressure Rise test.....	6
12.3.2.2	Helium Leak Detectors.....	6
12.4	Procedure for Helium Leak Tightness and Testing.....	7
12.4.1	Equipment.....	7
12.4.2	Pumping System	7
12.4.2.1	Detection System.....	8
12.4.2.2	Miscellaneous	9
12.4.3	Preliminaries	9
12.4.3.1	Initial Checks on the Leak Detection System	9
12.4.3.2	Pump-down.....	9
12.4.3.3	Background Determination.....	10
12.4.4	Leak Detector Calibration.....	10
12.4.4.1	Response and Cleanup Time Measurement.....	10
12.4.5	Cold Leak Tests	11
12.4.5.1	Global Leak Check.....	11
12.4.5.2	Probe Tests.....	12
12.4.5.3	Acceptance Criteria.....	13
12.4.6	Hot Leak Check.....	13
12.4.6.1	Test Conditions	13
12.4.6.2	Global Leak Check with the Component under test Hot	14
12.4.6.3	Probe Test	14
12.4.6.4	Final Cold Acceptance Check	15

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 3 of 16

12.4.6.5	Acceptance Criteria.....	15
12.5	Responsibilities	15
12.6	Reporting.....	16

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 4 of 16

12 Vacuum Leak Tightness and Testing

12.1 Scope and Status

As an Appendix to the ITER Vacuum Handbook, the status of this document is advisory and not mandatory on the supplier of any component. Nevertheless, it is strongly advised that the requirements of this document are adhered to for the supply of vacuum components to ITER.

The purpose of this Appendix is to define the criteria for the leak tightness of vacuum related components supplied to ITER. It is applicable to equipment destined for use on the ITER facility and any other area on site, which utilises items and assemblies with a vacuum boundary. It defines the test criteria and gives general instruction and guidelines to those persons, be they on site at the supplier, on site at ITER, or as part of an off site organisation which is called upon to perform vacuum helium leak detection.

12.2 General

Tests shall be performed both at ambient temperature and at the maximum and minimum working temperatures of the component, with the pressure differential in the same direction as for operation of the component. Where possible, component parts shall be tested before assembly. However, final assemblies must also be tested.

Where it is not envisaged that leak tests will be performed at cryogenic temperatures on vacuum components which are for use on cryogenic systems, a method of "thermal shocking" of welded connections shall be agreed in advance.

The supplier is responsible for all jigs, seals and equipment to allow the leak tightness to be proven across all vacuum boundaries, unless otherwise stated in the contract. Where pressure testing is required, this must always be performed prior to final vacuum leak testing. Acceptance tests shall wherever possible use the same type of seal which shall be used after installation of the component.

The supplier is responsible for the supply of tooling and methodologies for the subsequent removal of jigs, seals, temporary closure plates, etc., which have been fitted to components to facilitate the leak testing of such components.

The leak test method shall be agreed in advance with ITER. This will involve the submission for approval of a procedure as part of an external supply contract. The procedure should describe how the leak test will be performed, and include configuration diagrams and full details of the equipment to be used etc.

The ITER Vacuum Responsible Officer (RO) will nominate a Vacuum Specialist to witness the acceptance leak tests and any other leak test deemed necessary as part of a manufacturing process.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 5 of 16

In no circumstance shall **any** vacuum equipment be installed without an *accepted* pre-installation leak check being performed at the ITER site, without the express permission of the ITER Vacuum Responsible Officer. This applies to **all** Vacuum Quality Classifications.

12.3 Leak testing Methodologies

This Appendix describes recommended procedures for carrying out the most widely used methods of helium leak testing; it does not consider all available methods. Other methods may be used, but only with the prior approval of the ITER Vacuum RO

12.3.1 Over Pressure Methods

Over-pressure methods enable thin-walled vacuum chambers to be leak tested which might otherwise collapse under vacuum. This method is also useful when the equipment to be tested is already filled with a gas which can be used as the test gas. However the test gas which flows out through any leaks always mixes with contaminants present in the air, and this might reduce sensitivity.

12.3.1.1 Mass Spectrometer Sniffing Probe

Helium, or some other suitable gas, is used to slightly pressurise the component to be tested and a sampling probe “sniffs” for leaks. Helium passing through the leak is sampled from the surrounding atmosphere through a long narrow flexible tube which is connected to a mechanical pump to give a drop in pressure from atmosphere to about 10^{-2} Pa at the ion source of a mass spectrometer detector. Traces of helium or halogen in the environment can also be detected, which may lead to errors in the measured leak rate.

The helium content of atmospheric air limits the sensitivity of the sampling probe, and the detection limit is typically $\sim 1 \times 10^{-7}$ Pa m³ s⁻¹ if the volume is filled with pure helium (or the tracer gas appropriate for the detector used such as argon).

The sampling tube should be as short as possible to reduce the response time of the gas flow of the air-helium mixture from the entrance of the tube to the detector. The flow rate may also be limited by the available pumping throughput.

12.3.1.2 Probe Leak Testing (vacuum box or suction cup method)

Open objects can be tested using the vacuum box or suction cup method. A partial enclosure which can be evacuated by a leak detector is tightly pressed against the wall of the component being tested. The enclosure is evacuated and helium tracer gas applied to the opposite surface of the wall by a spray gun or other means. Helium leaking through the wall can pass to the detector via the vacuum box. This method of leak detection is widely used for the testing of welds on incomplete enclosures. The sensitivity is usually limited by diffusion of helium through the seal between the evacuated enclosure and the component wall.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 6 of 16

12.3.1.3 Pressurisation – Evacuation (“bombing”) Test

Hermetically sealed objects which cannot be pumped out can be leak tested using the so-called “bombing” method. The component to be tested is subjected to a high pressure of tracer gas, usually helium, to force gas into the component through any leaks present. After flushing to remove adsorbed tracer gas from the surface of the component, it is placed in a vacuum chamber which is connected to a leak detector. This can then detect any tracer gas passing out of the sealed volume through the leaks. This method is usually employed as a “go/no go” test since it is very difficult to locate the position of any leaks on such components.

12.3.2 Vacuum Leak Detection Methods

12.3.2.1 Pressure Rise Test

A pressure rise test is a useful way of determining the overall magnitude of any leaks present in a component.

A vessel to be tested of volume V is evacuated and sealed off. The pressure rise ΔP is measured over a time interval Δt and the leak rate q_L (at constant temperature) is evaluated from:

$$q_L = V \cdot \frac{\Delta P}{\Delta t}$$

This calculated leak rate also includes contributions from any other gas sources such as virtual leak and outgassing.

Real leaks may be distinguished from other sources of pressure rise since a real leak gives a pressure rise which is strictly proportional to time, while virtual leaks and outgassing result in an initially rapid pressure rise which tends to level off after some time

12.3.2.2 Helium Leak Detectors

These are based on a mass spectrometer, usually a small magnetic sector device. Leak detection can begin only when high vacuum conditions are obtained in the mass spectrometer. Due to its high sensitivity this method is the most frequently used method of leak detection for vacuum applications. The inlet pressure at the entrance to the leak detector depends on the design of the unit, but can range from atmosphere down to about 10^{-4} Pa.

Helium is usually used as the tracer gas, but other gases such as argon, neon, krypton, hydrogen and mixed gases may be used with the mass analyser suitably tuned. Modern helium leak detectors are usually supplied with the capability of detecting H_2 , He^3 , and He^4 .

To increase the helium detection sensitivity and improve detector stability, the mass analyser in helium leak detection systems is often de-tuned to give lower mass resolution. This can lead to a contribution to the measured mass 4 intensity from mass 2

ITER Vacuum Handbook : Appendix 12

Revision: 1.4

Date: September 16th, 2009

Page 7 of 16

and mass 3, thus giving a higher leak detector background signal at mass 4. For large component leak testing at high sensitivity, it may be necessary to reduce the partial pressure of hydrogen at the analyser by selectively pumping it with a getter in series with the leak detector input. It may also be necessary to selectively pump condensable gasses at the leak detector inlet. This can be achieved by the addition of a cold (e.g. liquid nitrogen) trap in series with the inlet.

12.4 Procedure for Helium Leak Tightness and Testing

12.4.1 Equipment

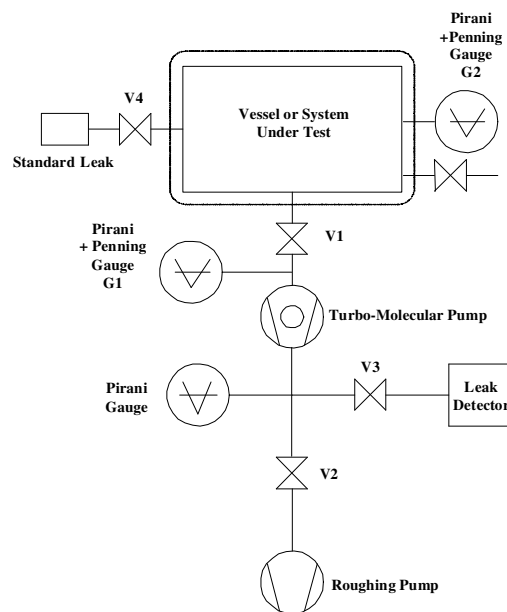


Figure 12-1 Typical Leak Detection Equipment

12.4.2 Pumping System

An indication of the basic elements of a pumping system, which could be used for leak detection, is illustrated in Figure 12-1. In this form it consists of the following items: -

1. A turbo-molecular pump isolated by a valve V1 and backed by a roughing pump via a valve V2, of enough pumping capacity to pump the system under test down to a suitable pressure at the inlet of the leak detector. Ideally all fittings and seals (at least those on the high vacuum side) should be all-metal to alleviate the problem of helium permeation.
2. A Pirani gauge to measure the pressure in the backing line of the turbo-molecular pump and a pressure gauge system (G1) on the high vacuum side of the turbo-molecular pump (but below valve V1) capable of measuring in the range 0.1 MPa to 10^{-7} Pa.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 8 of 16

Possible additional options to this pumping system could include a quadrupole or other type of mass spectrometer to measure the residual gas spectrum. This is essential if system cleanliness is to be assessed. A hydrogen getter and liquid nitrogen trap may be used to lower the detector background signal.

A vent valve on the vessel side of V1 is also advisable for venting the item under test to a clean dry gas such as nitrogen to retain cleanliness.

12.4.2.1 Detection System

This is the system used to detect any vacuum leaks which may be present, thus it is the central part of the system and normally consists of the following items:

1. A helium mass spectrometer leak detector installed such that it can be connected into the backing line of the turbo-molecular pump through valve V3. For maximum leak detection sensitivity, it should provide the necessary backing pressure for the turbo-molecular pump. It therefore should have its own pumping system comprising a turbo-molecular and backing pump combination. It must be able to detect leaks at least one order of magnitude smaller than that required by the specification of the item under test, and up to at least $100 \text{ Pa m}^3 \text{ s}^{-1}$.

It should be noted that with modern leak detectors, it is possible to suppress the background and gain up to 2 orders of magnitude in sensitivity. Although this mode is useful in localising leaks, it shall not be used for the purpose of acceptance testing without prior approval by the ITER Vacuum RO.

An alternative when the item under test is of relatively small volume of less than 1 m^3 , and when only a simple cold leak test is required, is to use the mass spectrometer leak detector on its own. In this case the leak detector is connected directly to the item under test. The separate turbo-molecular and roughing pump system is not required.

If there is a large leak on the item to be tested or where the pumping system is incapable of pumping the item under test to a sufficiently low pressure for the leak detector to be connected directly to the backing line of the turbo molecular pump, valve V2 may be left open and valve V3 partially opened so that the leak detector samples part of the gas stream to the backing pump. This configuration may be used to locate, but not size, any leaks.

2. A pressure gauge system (G2) on the vessel under test, capable of measuring in the range 0.1 MPa to 10^{-7} Pa .
3. A calibrated helium standard leak of value commensurate with the magnitude of leak rate required by the specification of the item under test, mounted on the system under test, and isolated by valve V4. Traceable calibration certificates shall be kept for this item and these should be readily available.
4. A helium bag or other enclosure fashioned in such a way that the test gas can surround all parts of the item under test with a concentration preferably exceeding 50% in air.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 9 of 16

5. A system for continuous recording of the leak test process. This can be achieved by using an analogue recording device such as a paper strip chart recorder connected to the output of the helium mass spectrometer leak detector or by continuous logging (and display) of data on a computer or dedicated data logger.

12.4.2.2 Miscellaneous

The following equipment is optional but experience has shown the items to be of use in helium leak tests.

1. A standard vacuum cleaner to pump the helium enclosure out if it is a sealed collapsible type such as a plastic bag before inflating it with helium, to ensure maximum concentration of the helium in the enclosure.
2. A helium-in-air concentration monitor to ascertain the percentage of helium in the bag or other enclosure during the test.
3. A triggered helium spray gun for subsequent probe testing of the item to localise any leaks found during the global leak test.

12.4.3 Preliminaries

12.4.3.1 Initial Checks on the Leak Detection System

1. With valve V2 open and valves V1 and V3 closed, the roughing pump is started. When the pressure falls to a suitable level, the turbomolecular pump is started and left until the pressure on gauge G1 stabilises.
2. The leak detector is switched on and when it is ready, an internal calibration is carried out as per the manufacturer's instructions.
3. The backing line Pirani gauge pressure reading is noted and valve V3 is carefully opened so that the leak detector does not trip out. (Most modern leak detectors can cope with this.)
4. The roughing pump valve V2 is closed.
5. When a relatively stable reading has been obtained on the leak detector, a leak check is carried out, by using a helium gun to probe with helium gas all joints and welds up to and including the pumped sides of V1 and V3.
6. If any leaks are found of magnitude greater than one decade smaller than the maximum leak rate called for in the specification of the item under test, then these shall be rectified and this sequence repeated until no such leaks are found.

12.4.3.2 Pump-down

Before the leak test can be undertaken, the item under test must be pumped down to the requisite pressure. In the case of the system shown in Figure 12-1 which uses a turbo-molecular and roughing pump set, the following actions shall be performed.

1. The roughing pump is started and valves V1 and V2 are opened.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 10 of 16

2. When the system Pirani pressure reaches the level given in the manufacturers instructions the turbo-molecular pump is started.
3. The system is ready for initial tests when the pressure reaches 10^{-3} Pa or lower on G1, or such other pressure specified as suitable by the manufacturer of the leak detector. If it does not reach this pressure then there may be a large leak present which must be located and rectified. It should be located using either an overpressure technique as described in Section 12.3.1.1 or the procedures of Section 12.4.5.2 but with valve V3 only partially opened so that the pressure at the inlet of the leak detector remains below the upper pressure limit specified by the manufacturer with the gas flowing to the roughing pump being sampled into the leak detector.

12.4.3.3 Background Determination

After a stable pressure reading has been obtained on gauge G2 with valves V1 and V2 open and the turbomolecular pump set running normally, with the leak detector fully functioning and the data logging device connected and operating, then the roughing valve V2 is closed and the leak detector valve V3 opened.

The leak detector reading is monitored until it has stabilised, without any electronic correction. This should take around 10 minutes, but the time can be longer depending on the size of the system under test.

This reading is recorded as the background level. Any reading above this value during the overall test constitutes a positive indication of a leak.

12.4.4 Leak Detector Calibration

With the system in the state as above for background determination, leak detector calibration shall be performed.

Valve V4 is carefully opened and the reading on the leak detector monitored until it is stable. This should correspond to the value of the standard leak to within $\pm 5\%$ after suitable corrections for the age of the standard leak and its temperature have been applied.

If a response time measurement is not required, then V4 is closed and the reading should then return to the background level.

12.4.4.1 Response and Cleanup Time Measurement

This should be done for a large system or where there is a long path length involving small bore tubes. This ensures that the duration of the overall test will be valid.

1. With the standard leak open to the system and the leak indication stable at the value of the standard leak, suitably corrected for age and temperature, valve V4 is closed.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 11 of 16

2. The time taken for the reading on the leak detector to return to the background level is recorded. This is the cleanup time for the system and will depend on the applied pumping speed for helium and the configuration of the system under test.
3. When the background level has been attained, valve V4 is opened and the time taken to return to the level of the standard leak indication, suitably corrected, is recorded. This is the response time for the system.
4. Valve V4 is closed and the system is allowed to return to the background level.
5. This concludes the initial set-up tests and the overall leak test may then be undertaken.

12.4.5 Cold Leak Tests

12.4.5.1 Global Leak Check

If all the preceding conditions have been met with all equipment functioning and ready for use, a global cold leak test may be carried out according to the following procedure.

1. The data recording system is connected to the output of the leak detector and started and the date and time are recorded.
2. Valves V1 and V3 are opened and valves V2 and V4 are closed.
3. When the background reading is stable and is at a level consistent with the leak specification of the item under test, which will be for most purposes at least an order of magnitude lower than the specified maximum leak rate of the component under test and without electronic correction, the global leak check may be started.
4. The component under test is surrounded by a suitable helium enclosure. If the helium enclosure is a flexible type, it should have as small a volume as possible. The enclosure is filled with helium to a concentration of at least 50% in air and the time is recorded in the data log
5. Helium should remain in contact with the item under test for at least 10 minutes or longer, depending on the size of the object and the response time previously measured, or for the time specified in the test specification for the component under test, whichever is longer.

In the case of components where there might be possible low conductance leak paths, for example porosity, the time required for a sensible test may be significantly longer than the response time measured for the system using the techniques of Section 12.4.4.1. Details of the method and time of duration of helium application shall be included in the leak testing procedure to be *accepted* by the ITER Vacuum Responsible Officer.

6. Where the helium enclosure is not completely sealed, then suitable precautions shall be taken to ensure that helium cannot back-diffuse through the roughing pumps and/or the leak detector pumps into the mass spectrometer detector. In the

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 12 of 16

case of long-duration global tests, it may be advisable to house these items in a separate enclosure held at a small positive pressure above atmosphere.

7. After the appropriate time interval, the helium supply is closed off (where appropriate), and the enclosure vented to atmospheric air and removed. The time is recorded in the data log.
8. If the leak rate indication on the leak detector has not risen by more than the specified maximum leak rate at any time during this test procedure, the item under test shall be deemed to have passed, subject to the requirements of Section 12.4.5.3.
9. It may be advisable to recheck the background reading and leak detector calibration if the global test has been of significant duration. When that has been done according to the procedures of 12.4.3.3 and 12.4.4, then the global leak test is complete.
10. Valves V1 and V3 are closed and valve V2 opened.
11. The item is vented, or left under vacuum for further work as required.
12. If the leak rate reading during the test has at any time exceeded the specification value, then the item has failed the test, and the leaks shall be located using the procedures of Section 12.4.5.2.

12.4.5.2 Probe Tests

These are necessary to locate any leaks greater than the value in the specification of the component being tested which may have been indicated during the global test. They may be required not only at this stage, but may be needed also after the hot global test and the final cold global test, if those two tests are required as part of the contract or other instruction.

The following procedure shall be used, although others are possible and may be used after prior agreement.

1. Any helium enclosure or other covering or obstruction is removed from the item under test wherever possible.
2. If the component under test is at cryogenic temperatures, it may have to be warmed to ambient temperature before probe tests can be carried out.
3. Valves V1 and V3 should be open and valves V2 and V4 should be closed.
4. In the case of a large item, the data logging system shall continuously record the leak detector signal so that any longer term variations in leak rate may be observed.
5. Using a helium gun, helium gas is sprayed over or into all suspect locations and under any non-removable coverings, starting at the top of the item under test and working down as required. The helium spray should be introduced to the area under test for a time period consistent with the response time of the system measured in accordance with Section 12.4.4.1

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 13 of 16

6. If a leak indication is found, then the point of maximum reading shall be localised. For subsequent testing to localise any other leaks, it is advisable to blanket that point with a physical barrier such as a polythene bag or sheet or with a stream of another gas whilst checking the remainder of the system.
7. When all detectable leaks have been located, then the leak detector is isolated by closing valve V3. Valve V1 is closed and the item under test shall be vented to dry nitrogen or clean dry air admitted through the vent valve. The ITER Vacuum Responsible Officer shall be contacted to agree a procedure to rectify the leak or leaks.
8. When any agreed repair has been successfully accomplished, the process starting from stage 12.4.3.2 and to point 10 at the end of stage 12.4.5.1 is repeated until the item is proved to meet the relevant specification.

12.4.5.3 Acceptance Criteria

If all the stages above have been successfully completed then the item under test may be accepted by the ITER Vacuum Specialist as having met the relevant specification provided that the following conditions have been met.

1. The leak detector has been correctly calibrated and its calibration value is within $\pm 5\%$ of the standard leak rate value as corrected for the ambient temperature and the age of that item and that standard leak rate value is commensurate with the value of the maximum leak rate specified for the item under test.
2. The leak test has been performed by suitably qualified and experienced personnel to the *accepted* procedure, with no significant deviation from that procedure and has been witnessed by the ITER Vacuum Specialist.
3. The leak rate value as measured by the leak detector has not increased in value above the measured background to a value greater than the specified leak rate during the entire duration of the global leak test.

The location and magnitude of all identified leaks shall be recorded. Normally, all practicable efforts shall be made by means agreed with the ITER Vacuum Responsible Officer to reduce any leak discovered during the manufacturing phase to a level lower than the limit of detection of the leak detection method used for the tests.

12.4.6 Hot Leak Check

12.4.6.1 Test Conditions

If it is required as part of the contract or other instruction to perform a hot leak test on an item which during its life may be subject to increased temperature usage, then the following procedure shall be carried out.

1. Before commencing any part of this leak test procedure, the item under test must have completed one or more temperature cycles as specified and be at that point on the cycle where it is specified that the hot leak test shall take place.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 14 of 16

- | | | |
|---------------|---|---------------|
| Revision: 1.4 | Date: September 16 th , 2009 | Page 14 of 16 |
|---------------|---|---------------|
2. The leak detector shall be set up using the procedures of Sections 12.4.3.3 and 12.4.4. If the response time of the system has already been determined, or is not required, it need not be re-measured.
 3. If the background is elevated when the item under test is at temperature (as may often be found), then the conditions stipulated in 12.4.5.1 Point 3 may not be met. However with judicious choice of scale it may be possible to do a perfectly valid leak check at a raised background level. It may also be necessary to selectively pump hydrogenic species from the leak detector input gas stream. This can be done by the correct choice of getter installed in series with the leak detector inlet. The applicable conditions for this test must be agreed with the ITER Vacuum Responsible Officer.
 4. The helium enclosure used for these tests must be capable of tolerating temperatures above ambient since the increased thermal conductivity of helium will raise the temperature of this item above the level it would reach with only atmospheric air in the enclosure.

12.4.6.2 Global Leak Check with the Component under test Hot

Essentially, this is a repeat of the cold global leak test described in Section 12.4.5.1 except that, if a leak indication is observed, the item may need to be cooled down before probe tests can be performed. The temperature at which the hot leak test is performed shall be recorded and shall be within the limits as specified in the leak testing procedure.

If, with the component at the specified hot temperature, no leak rate of size greater than that specified for the component has been observed, then provided that the conditions of Section 12.4.5.3 have been met, the component will be deemed to have satisfied the hot leak test requirement.

If, however, with the component at the specified hot temperature, a leak rate of size greater than that specified for the component has been observed, then a probe test to localise any leaks present must be undertaken.

The supplier should be aware that under some conditions, a leak may be observed at temperature but may disappear when the component is cooled to ambient temperature. If this is the case, then it may be necessary to implement an agreed procedure for leak location at elevated temperature.

12.4.6.3 Probe Test

1. This method of probe leak testing baked components is the essentially the same procedure as detailed in 12.4.5.2., but with additional steps as noted below:
2. If the probe test cannot be carried out at the hot temperature, the component shall be cooled to ambient temperature
3. Steps 1 – 7 of section 12.4.5.2 shall be carried out.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 15 of 16

- | | | | |
|---|---------------|---|---------------|
| ITER Vacuum Handbook : Appendix 12 | Revision: 1.4 | Date: September 16 th , 2009 | Page 15 of 16 |
|---|---------------|---|---------------|
4. If, after probe testing at ambient temperature, no leak has been identified, then, as agreed with the ITER Vacuum Responsible Officer, a further temperature cycle shall be completed as specified up to the point on the cycle where it is specified that the hot leak test shall take place.
 5. Then either
 - a. an agreed procedure for leak location at this elevated temperature shall be carried out
 - or
 - b. the component shall be cooled and step 2 of this Section shall be carried out in the hope that the hot leak may have opened up further and now may be detectable at or close to ambient temperature.
 6. Step 5 shall be repeated until no leaks which have not been localised are evident at the hot temperature.
 7. When all detectable leaks have been located and the component is close to ambient temperature, then the leak detector is isolated by closing valve V3. Valve V1 is closed and the item under test shall be vented to dry nitrogen or clean dry air admitted through the vent valve. The ITER Vacuum Responsible Officer shall be contacted to agree a procedure to rectify the leak or leaks.
 8. When any agreed repair has been successfully accomplished, the global hot leak test procedure of this Section is repeated.

12.4.6.4 Final Cold Acceptance Check

This test shall be carried out following a satisfactory global hot leak test procedure when the item under test has cooled down to a temperature in the range 60°C to 80°C, since experience has shown that small leaks can be blocked by water vapour below this temperature.

It shall follow the procedures of Section 12.4.5.1.

12.4.6.5 Acceptance Criteria

These shall be the same as those specified in Section 12.4.5.3

12.5 Responsibilities

It shall be the responsibility of the supplier to ensure that all vacuum leak tests carried out off-site and of the ITER Vacuum Responsible Officer when such tests are carried out on-site that they be performed in accordance with the contract or other specification. All deviations from such specification or agreed variation thereof shall require a non-conformance to be raised covering each specific case. In the case of any particular component, a nominated ITER Vacuum Specialist may witness the tests.

ITER Vacuum Handbook : Appendix 12		
Revision: 1.4	Date: September 16 th , 2009	Page 16 of 16

All records as detailed in the following section shall be completed and shall become part of the final document package for the component concerned.

12.6 Reporting

Full records of the tests carried out on any component shall be completed in order to maintain traceability of the leak test history of a particular item. The records shall consist of the following.

1. Data records of the output of the leak detector for all the global tests specified including the standard leak calibration and response time determination. These data records shall include the date and time of all tests as well as anything else of relevance, such as the start and finish time of helium gas application to the item under test.
2. A record of the helium concentration during the leak test where that is required. In the case of a simple cold leak test this will be on request of the ITER Vacuum Responsible Officer, but in the case of a full cycle of leak testing involving temperature variation it will be required.
3. A record of the system total pressure throughout a temperature cycle since it may pinpoint the time when a leak opened up and be instrumental in the subsequent diagnosis of the leak.
4. The make, model and date of manufacture of the helium mass spectrometer leak detector used in the tests.
5. The nominal value of all standard leaks used, their date of calibration, ageing and temperature characteristics, and the ambient temperature(s) experienced during the tests.
6. The results of all tests showing whether it was a pass or fail, and, if a failure, the measured leak rate and the location of the leak, together with the steps taken for any repair or elimination.

The magnitude and location (if applicable) of **all** leaks identified during testing shall be recorded. This includes leaks of magnitude lower than the acceptance criteria for which no remedial action may have been taken.