TIC
TANTALUM-NIOBIUM
INTERNATIONAL STUDY CENTER
Bulletin No.185
APRIL 2021
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When shipment is denied

And solutions that are being applied (see page 8)

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EU and UK Conflict Minerals Regulations

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Next generation niobium-bearing reinforcing bar steels

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President’s Welcome

Dear Members and friends,

It seems like only last week I was writing to you for the January issue of the Bulletin. Time seems to have a way of passing too quickly during these times of self-quarantine. In fact, I recently went to my office after one year of being away and only because I have received both my Covid vaccinations. It seemed strange as there were only 3-4 people in an office set up for over 150 people. Looking ahead, most businesses are trying to determine how mobile work will fit in with the future business model. Before the pandemic, many would have thought we could not continue at the same pace with people not going to an office every day; however, we have learned how to adjust to this change, and very successfully. Now people are looking forward and considering how to work in a “hybrid model” with mobile and office work coexisting. As with all things associated with this pandemic, it bears proof that while people do not like change, in most cases we learn and grow through change.

As we get closer to our 62nd General Assembly (GA62) and look at the progress in reducing the number of Covid cases around the world, while we remain positive on the ability to have an in-person event in Switzerland this September, we are also considering how we might incorporate a hybrid model if we are restricted by the number of in-person attendees in Geneva. The decision depends on a number of factors, most importantly the progress towards declining instances of Covid around the world. Additionally, the potential need for quarantine is a major barrier to our plans as well as Swiss acceptance of individuals from different countries. The platforms for such a hybrid event have evolved significantly and we are confident that, if necessary, we can be successful with a hybrid meeting (some in-person attendees and some remote attendees). Given that we had to cancel last year’s in-person GA, my clear preference is for a 100% in-person event; however, as much is out of our control we must once again consider options that best suit our members and the situation. This will all be discussed at the up-coming Executive Committee meeting on April 29th.

This issue of the Bulletin contains a number of interesting articles, among them 1) an update on tantalum raw materials transport, 2) an interview with Rashad Abelson, OECD legal expert for supply chain due diligence/ responsible minerals, and 3) next generation niobium reinforcing bar steels. Please enjoy these articles.

Lastly, I hope you and your families are safe and healthy. This remains the number 1 focus for all.

With sincere regards,

Daniel F. Persico, Ph.D., President

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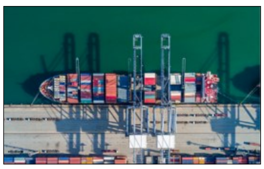
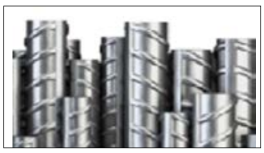




Regular articles:

主席致辞

亲爱的会员和朋友们：

似乎就在上个星期，我还在为一月份的期刊给你们写信。在这段自我隔离的日子里，时间似乎过得特别快。 事实上，我在离开一年后再从回我的办公室，只是因为我已经接受了两次新冠肺炎疫苗注射。 这似乎很奇怪，因为在一个可以容纳150多人的办公室里只有3-4个人。 展望未来，大多数企业正试图确定移动工作将如何与未来的商业模式互相适应。在在疫症爆发前，许多人会认为如果我们不能每天去办公室，就很难以同样的步速继续下去；然而，我们已经学会了如何适应这种变化，而且非常成功。 现在，人们正在向前看，考虑如何以 "混合模式 "工作，使移动和办公工作共存。正如与这种大流行病有关的所有事情一样，它证明了尽管人们不喜欢变化，但在事实证明在大多数情况下，我们通过变化而学习和成长。

随着我们离第62届大会（GA62）越来越近，看着世界各地新冠肺炎病例的减少，我们对于今年9月在瑞士举行实体会议的能力仍保持乐观，但我们也在考虑，如果我们受到日内瓦现场与会者人数的限制，我们可以如何整合一个混合会议模式。 这一决定取决于许多因素，最重要的是全球疫症病例减少。 此外，瑞士对来自不同国家的个人检疫需求也是我们计划的一个主要障碍。这种混合活动的平台已经有了很大的发展，我们有信心，如果必要时，我们可以通过混合会议（一些亲临现场的参会者和一些远程参会者）取得成功。 鉴于我们不得不取消去年的实体大会，我明确希望能100%参加实体会议； 然而，由于很多事情是我们无法控制的，我们必须再次考虑最适合我们成员情况的方案。这一切将在4月29日举行的执行委员会会议上讨论。

本期期刊包含一些有趣的文章，其中包括：1）钽原料运输的最新情况，2）对经合组织供应链尽职调查/负责任的矿产法律专家Rashad Abelson的采访，以及3）下一代铌钢筋。 请欣赏这些文章。

最后，我希望你和你的家人都安全和健康。 这仍然是第一位的重点。

致以诚挚的问候，

丹尼尔·佩尔西科博士（Daniel Persico）， 主席

Lettre du Président

Chers membres et amis,

Il me semble que la semaine dernière encore, je vous écrivais pour le numéro de janvier du Bulletin. Le temps semble avoir une façon de passer trop vite pendant ces périodes d'auto-confinement. En fait, je me suis récemment rendu à mon bureau après un an d'absence et uniquement parce que j'avais reçu mes deux vaccins Covid. Cela semblait étrange car il n'y avait que 3-4 personnes dans un bureau prévu pour plus de 150 personnes. Pour l'avenir, la plupart des entreprises tentent de déterminer comment le travail mobile s'intégrera dans leur futur modèle d'entreprise. Avant la pandémie, beaucoup auraient pensé que nous ne pouvions pas continuer au même rythme avec des personnes ne se rendant pas au bureau tous les jours ; cependant, nous avons appris à nous adapter à ce changement, et avec beaucoup de succès. Aujourd'hui, les gens se tournent vers l'avenir et réfléchissent à la manière de travailler dans un "modèle hybride" où coexistent le travail mobile et le travail de bureau. Comme tout ce qui est associé à cette pandémie, cela prouve que même si les gens n'aiment pas le changement, dans la plupart des cas, nous apprenons et grandissons grâce au changement.

À l'approche de notre 62ème Assemblée Générale (GA62) et vu les progrès réalisés dans la réduction du nombre de cas de Covid dans le monde, si nous restons positifs quant à la possibilité d'organiser un événement en présentiel en Suisse en septembre, nous réfléchissons également à la manière dont nous pourrions intégrer un modèle hybride si nous sommes limités par le nombre de participants en personne à Genève. La décision dépendra d'un certain nombre de facteurs, dont le plus important est la diminution des cas de Covid dans le monde. En outre, la nécessité potentielle d'une quarantaine est un obstacle majeur à nos plans, ainsi que l'acceptation par la Suisse de personnes de différents pays. Les plateformes pour un tel événement hybride ont considérablement évolué et nous sommes convaincus que, si nécessaire, nous pouvons réussir avec une réunion hybride (certains participants en présentiel et certains participants à distance). Étant donné que nous avons dû annuler l'AG en présentiel l'année dernière, ma préférence va clairement à un événement 100% en personne; cependant, comme beaucoup de choses sont hors de notre contrôle, nous devons une fois de plus envisager les options qui conviennent le mieux à nos membres et à la situation. Tout ceci sera discuté lors de la prochaine réunion du Comité Exécutif le 29 avril.

Ce numéro du Bulletin contient nombre d'articles intéressants, parmi lesquels 1) une mise à jour sur le transport des matières premières de tantale, 2) une interview de Rashad Abelson, expert juridique de l'OCDE pour le devoir de diligence de la chaîne d'approvisionnement/les minerais responsables, et 3) les barres d'armature en niobium de la prochaine génération. Je vous invite à lire ces articles.

Enfin, j'espère que vous et vos familles êtes en sécurité et en bonne santé. Cela reste l'objectif numéro 1 pour tous.

Avec mes sincères salutations,

Daniel F. Persico, Ph.D., Président

社長のあいさつ

会員の皆様、お友達の皆様。

先週、会報1月号のために皆さんに手紙を書いていたのが、まるで先週のことのようです。このような自粛期間中は、時間が経つのがあまりにも早く感じられます。実は最近、1年ぶりに事務所に行ったのですが、その理由はコビットの予防接種を両方とも受けたからでした。150人以上が働くオフィスに3〜4人しかいないのは不思議な感じがしました。将来を考えると、ほとんどの企業は、モバイルワークが将来のビジネスモデルにどのように適合するかを判断しようとしている。パンデミックが発生する前は、多くの人が、人々が毎日オフィスに行かない状態で同じペースで続けることはできないと考えていたでしょう。しかし、私たちはこの変化に適応する方法を学び、非常にうまくいっています。しかし、私たちはこの変化に適応する方法を学び、非常にうまくいっています。今、人々は前を向き、モバイルとオフィスワークが共存する「ハイブリッドモデル」で働く方法を考えています。今回のパンデミックに関連したすべてのことがそうであるように、人は変化を好まないが、ほとんどの場合、人は変化を通して学び、成長するということを証明している。

第62回総会（GA62）が近づき、世界中のCovid感染者数の減少に向けた進捗状況を見ながら、今年の9月にスイスで直接参加型のイベントを開催できることを前向きに検討していますが、ジュネーブでの直接参加者の数に制限がある場合は、ハイブリッドモデルをどのように取り入れるかについても検討しています。この決定は様々な要因に左右されますが、最も重要なのは、世界中でコヴィドの感染が減少する方向に進んでいることです。また、検疫が必要になる可能性があることも、スイスが様々な国の人々を受け入れることと同様に、私たちの計画にとって大きな障害となっています。このようなハイブリッドなイベントのためのプラットフォームは大きく進化しており、必要であれば、ハイブリッドなミーティング（一部の対面式の参加者と一部の遠隔地からの参加者）を成功させることができると確信しています。昨年の対面式GAをキャンセルしなければならなかったことを考えると、私は100%対面式のイベントを明確に希望しています。しかし、私たちにはどうしようもないことが多いので、メンバーと状況に最も適した選択肢をもう一度検討しなければなりません。この件については、4月29日に予定されているエグゼクティブ・コミッティで議論される予定です。

本号では、1）タンタルの原料輸送に関する最新情報、2）OECDのサプライチェーン・デューデリジェンス/責任ある鉱物に関する法律専門家であるラシャド・エーブルソン氏へのインタビュー、3）次世代ニオブ補強棒鋼など、興味深い記事が多数掲載されています。これらの記事をお楽しみください。

最後になりましたが、皆さんと皆さんのご家族が安全で健康であることを願っています。これは、すべての人にとって一番の関心事であり続けます。

最後になりましたが、皆様とご家族の安全と健康を願っています。

ダニエル・F・パースィコ、PhD、社長

Boas-vindas do Presidente

Prezados Membros e amigos,

Parece que faz apenas uma semana quando eu estava escrevendo para a edição de janeiro do Boletim. O tempo parece voar durante estes tempos de pandemia e necessidade de isolamento social. Recentemente tive a sorte de ser vacinado e pude finalmente retornar ao meu escritório após um ano de ausência. Devo dizer que foi bem estranho, pois havia apenas 3-4 pessoas em um escritório preparado para mais de 150 pessoas. Olhando para o futuro, a maioria das empresas está tentando determinar como o trabalho em home-office se encaixará no futuro modelo de negócios. Antes da pandemia, muitos teriam pensado que não poderíamos continuar no mesmo ritmo com pessoas que não vão a um escritório todos os dias; no entanto, aprendemos a nos ajustar a esta mudança, e com muito sucesso. Agora as pessoas estão olhando para frente e considerando trabalhar em um "modelo híbrido" com a coexistência de trabalho em home office e de escritório. Como em todas as coisas associadas a esta pandemia, é prova de que, embora as pessoas não gostem da mudança, na maioria dos casos aprendemos e crescemos através da mudança.

Na medida que nos aproximamos de nossa 62ª Assembleia Geral (GA62) e observamos o progresso na redução do número de casos Covid ao redor do mundo, enquanto continuamos positivos sobre a capacidade de ter um evento presencial na Suíça neste mês de setembro, também estamos considerando como poderíamos incorporar um modelo híbrido se formos restringidos pelo número de participantes presenciais em Genebra. A decisão depende de uma série de fatores, mais importante ainda, do progresso em direção ao declínio dos casos de Covid ao redor do mundo. Além disso, a necessidade potencial de uma eventual quarentena seria uma grande barreira para nossos planos, assim como a aceitação da Suíça de aceitar indivíduos de diferentes países. As plataformas para tal evento híbrido evoluíram significativamente e estamos confiantes de que, se necessário, podemos ter sucesso com uma reunião híbrida (alguns participantes presenciais e alguns participantes remotos). Considerando que tivemos que cancelar a AG presencial do ano passado, minha preferência seria certamente por um evento 100% presencial; no entanto, como isso está fora de nosso controle, devemos mais uma vez considerar todas as opções e decidir por aquela que melhor se adequar aos nossos membros e obviamente a toda circunstância atual. Tudo isso será discutido na próxima reunião do Comitê Executivo, a ser realizada no dia 29 de abril.

Esta edição do Boletim contém uma série de artigos interessantes, entre eles 1) uma atualização sobre o transporte de matérias-primas de tântalo, 2) uma entrevista com Rashad Abelson, especialista jurídico da OCDE para a devida diligência/minerais responsáveis pela cadeia de suprimentos, e 3) a próxima geração de aços com barra de reforço de nióbio. Espero que esses artigos possam lhe ser útil e que contribua construtivamente.

Finalmente, espero que você e suas famílias estejam seguros e saudáveis. Este continua sendo a nossa prioridade no momento! Com nossos mais sinceros cumprimentos,

Daniel F. Persico, Ph.D., Presidente

The A.G. Ekeberg Tantalum Prize

CALL FOR PAPERS 2021

Recognising excellence in tantalum research and innovation

The Anders Gustaf Ekeberg Tantalum Prize ('Ekeberg Prize') is awarded annually by the T.I.C. for excellence in tantalum research and innovation. It is sponsored by the T.I.C. and is central to the Association's efforts to publicise the many benefits afforded by this exceptional element.

Eligible publications must be in (or translated into) English and be dated between September 2019 and March 2021.

The prize-giving ceremony

The winner will be recognized by the tantalum industry and receive his/her prize medal, made by the Kazakhstan Mint from pure tantalum metal, at the 62nd General Assembly in Geneva, Switzerland, in September 2021. The General Assembly is open to both members and non-members; details are available at https://www.tanb.org/view/62nd-general-assembly.

Subjects for consideration

The Ekeberg Prize is awarded for the published paper or patent that is judged by an independent panel of experts to make the greatest contribution to understanding the processing, properties or applications of tantalum (Ta).

Suitable subjects may include, but are not limited to:

- Processing of tantalum minerals or other raw materials
- Tantalum used in capacitors or other electronic applications
- Tantalum metallurgy and mill products, including alloys
- The use of tantalum powder in additive manufacturing (3D printing) as pure metal or in an alloy
- Medical (including dental) applications of tantalum
- Recycling of tantalum-bearing scrap

To submit a publication please contact the T.I.C. office (info@tanb.org) by May 31st 2021.

Previous winners of the Ekeberg Prize

The Ekeberg Prize was established by the T.I.C. in 2017 to increase awareness of the many unique properties of tantalum products and the applications in which they excel. To date the Ekeberg Prize has been awarded for outstanding work on the subjects of tantalum capacitors (2018, Dr Yuri Freeman), additive manufacturing (2019, Nicolas Soro et al), and recycling tantalum by solvent extraction (2020, Prof. Love et al).

Technology-driven innovations will ensure the long-term future of the tantalum market and the Ekeberg Prize has shown that with so many potential new or embryonic applications in development there is every reason for optimism in the future. TIC

The 2020 Ekeberg Prize winners from the University of Edinburgh, UK, (left to right): Prof. Bryne Ngwenya, Luke Kinsman, Prof. Jason Love and Prof. Carole Morrison.

* Although T.I.C. represents and supports both tantalum and niobium equally, the Ekeberg Prize focuses on tantalum, because CBMM's Charles Hatchett Award (www.charles-hatchett.com) already superbly recognises niobium published research.

Difficulties in tantalum raw materials transport, and potential solutions

This paper was given by Ulric Schwela on behalf of the T.I.C. at the IAEA Technical Meeting on Denials of Shipment held online from March 23rd to 26th 2021. Mr Schwela was the T.I.C.'s Technical Officer 2005-2016 and is currently the Managing Director of Salus Mineralis Ltd, a specialist NORM transport consultancy which regularly works with the T.I.C. on NORM issues (he can be contacted at us@salusmineralis.com). The T.I.C. invests a lot of effort working with regulators and other stakeholders on issues concerning Naturally Occurring Radioactive Materials (NORM) and Denial of Shipment.

Executive Summary

Tantalum is a non-radioactive metal, present in rocks and ores that can be radioactive due to naturally occurring thorium and uranium. These raw materials require transport to facilities that have the specialist technology to extract the non-radioactive tantalum.

Most transport is by land and sea in large freight containers, some by air, and materials above 10 Bq/g require transport as Class 7 Dangerous Goods. Maritime transport of Class 7 is no longer viable for most companies, due to fewer carriers accepting Class 7 for transport, and on fewer routes.

The main reason for non-acceptance of Class 7 for transport is the financial risk to carriers of transporting a niche product that may see an entire container ship being delayed or rerouted due to a sudden refusal to accept it for transit or transhipment at a planned port of call, once the ship is already underway. Despite Class 7 being a premium product commanding a premium freight charge, the increased fee is far less than the financial cost of a delay or rerouting. Further, the transport of Class 7 (radioactive materials) suffers from an image problem, with the perception that these materials are somehow inherently more dangerous than other classes of dangerous goods (explosive, flammable, oxidising), whereas in fact the transport of radioactive materials has an excellent and enviable safety record.

A number of undesirable consequences have arisen as a result of these transport difficulties:

1) Almost every consignor of tantalum raw materials no longer even attempts to ship Class 7, and instead dilutes the radioactivity concentration to <10 Bq/g by blending with low grade materials, in order to be able to transport as general goods reliably.

2) A few consignors use air freight despite the greatly increased cost, the benefit being fast and reliable delivery.

3) A number of companies (that are not T.I.C. members), feel the necessity to consider shipping raw materials by sea as misdeclared cargo, in contravention of the transport regulations that govern road transport and international maritime transport, with the tacit acceptance of key stakeholders along the supply chain.

Nos. 1) and 2) represent less economical or sustainable transport solutions, with increased carbon footprint for the quantity of valuable metal transported. No. 3) is not only an offence, but also puts transport workers at potentially greater risk, and could damage other goods such as photosensitive material, if the carrier is not informed and can not take appropriate precautions. Also, no. 3) is an anti-competitive distortion of the market, as the receiving companies are able to obtain higher grade material at lower transport costs.

The recommendations are i.a. that resources should be allocated on a permanent basis to maintain awareness of denial of shipment issues through effective communication and inclusion in training programmes, with a view to promoting harmonisation in the implementation of transport regulations in different states, and thus create a level regulatory and competitive playing field for the economic benefit of all.

Figure 1: Reliable transport of Class 7 materials is essential to human health. For example, cobalt-60 is used to sterilise medical equipment in hospitals and treat certain cancers. Cobalt-60 has a half life of 5.3 years, meaning sources must be replaced regularly. Any delay or denial of shipment could directly result in (avoidable) fatalities (photo: Shutterstock)

Tantalum properties

Tantalum is a non-radioactive metal, which occurs in nature in rocks and ores that can be naturally radioactive due to thorium and uranium in the crystal lattice, and these ores require transport to facilities which have the specialist technology to extract the non-radioactive tantalum.

Tantalum is a refractory metal with a particular range of properties including high dielectric potential in its oxide form, high refractive index in optics, exceptional resistance to acids as a metal, utility as a micro alloying element, great hardness in its carbide form, and excellent biocompatibility as an implant.

A little over half of all tantalum is used in electronic applications, not only in electronic capacitors due to its dielectric potential being among the most volumetrically efficient in existence and with excellent uniform performance over a broad range of temperatures and under vibration, but also as a barrier layer between copper and silicon in semiconductors, and other technical applications in computer storage. It is the high-performance component of choice in demanding applications such as engine management units, borehole drill head sensors, heart pacemakers, and satellite electronics, where reliability is paramount. The full range of applications would make for a long list.

Figure 2: A tantalite crystal from Kenticha, Ethiopia (photo: T.I.C.)

In optical applications it helps lenses for glasses/spectacles and mobile phone cameras be made thinner and lighter. It resists almost all acids and is the only metal to have corrosion resistance equivalent to glass, only being dissolved by hydrofluoric acid. For this reason, it is used for chemical process equipment that handles particularly aggressive environments, and provides a longer service life thus reducing down time.

It is an essential microalloying element in a number of aerospace and turbine alloys, for jet engines and gas turbines, giving greater toughness and enabling higher operating temperatures, thus improving efficiency and service life. It also finds use as a carbide in cutting tools in e.g. the automotive industry.

Last but by no means least, its biocompatibility and ability to achieve a stiffness equivalent to bone, means that implants do not suffer adverse immune response, and indeed bone implants become incorporated by new bone growth.

The size of the tantalum market is equivalent to approximately 2'000 to 2'500 mt of Ta metal per year, which depending on the type and grade of material varies greatly in value. If taken as Ta metal, the total value would be of the order of $500M to $750M, although the overall value to society in terms of technology, functionality, efficiency, safety and medical uses, is inestimable.

It is because tantalum is irreplaceable in so many critical technologies that it is often among those natural resources deemed “critical” or “strategic” by economists and politicians (USA, EU, Japan, Canada etc - see Bulletin #184 for details).

Figure 3: Four applications where the unique properties of tantalum are employed (clockwise from top left): as a corrosion resistant lining of chemical processing equipment, in superalloys used in the hot section of gas turbine engines for electricity production, in the capacitors used in satellites, and as a barrier layer between copper and silicon in semiconductors on printed circuit boards. (images not to scale) (photos: Shutterstock)

Occurrence and need for transport

Present in the earth's crust at an average of 2 ppm (0.0002 %), tantalum deposits can be found all over the world, however they are generally at far too low concentrations to be economically viable, even considering the high value of tantalum metal. Some deposits have tantalum as a by-product or co-occurrence with other significant elements such as niobium, tin, tungsten, lithium or rare earths. The most important deposits in operation today are located chiefly in Australia, Brazil, DR Congo, Ethiopia, and Rwanda, as well as smaller or lower grade deposits in Bolivia, Burundi, China, Colombia, Mozambique, Nigeria, Russia and Sierra Leone (see Figure 4).

According to the United States Geological Survey, there are >110'000 mt of tantalum reserves in the world, not including central Africa where most tantalum raw materials are currently extracted. Given the size of the tantalum market, there is sufficient tantalum in the world for at least 50 years, and there is more yet to be discovered. As such, tantalum raw materials are plentiful.

The tantalum minerals contain tantalum in its pentoxide form Ta_2O_5, and within the same crystal lattice are also naturally occurring thorium and uranium which occupy the same crystal lattice spaces interchangeably. It is these intrusions of Th and U, together with their daughter elements, which make tantalum minerals radioactive, or Naturally Occurring Radioactive Materials (NORM). The total parent radioactivity concentrations range from 5 to 50 Bq/g, in a few cases more than 100 Bq/g.

In order to extract the tantalum from the minerals, the refractory nature means the mineral can not be separated by physical means at the mine site, and instead requires technically complex and hazardous digestion in hot hydrofluoric acid or equivalent processes, which can only be carried out at specialist processing plants.

These processing facilities are almost all located in another country from where the mines are, therefore necessitating transport. In all cases except some moderate tonnages within Brazil, China and Russia, transport is international. The international destination countries include China, Estonia, Germany, India, Japan, Kazakhstan, Mexico, Russia, Thailand, United States.

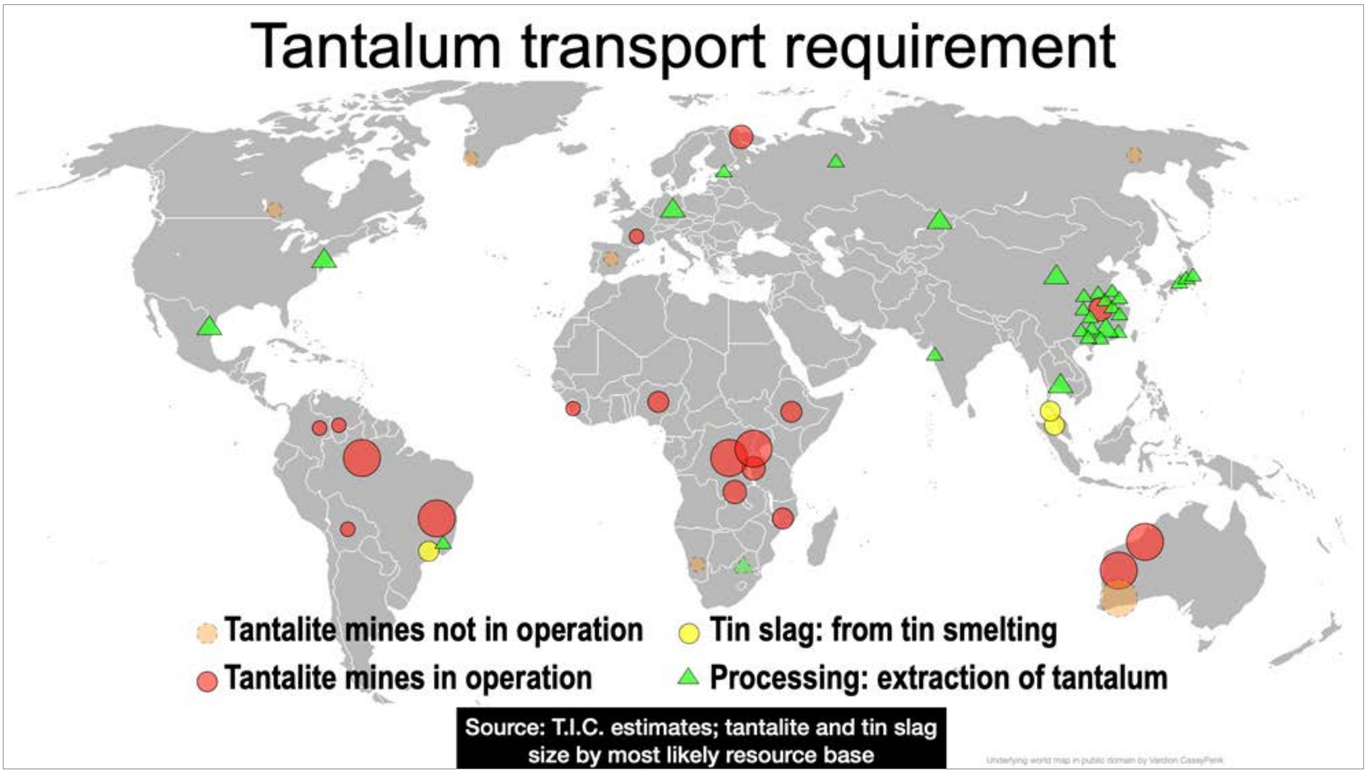


Figure 4: World map showing the location of tantalum deposits and the processing facilities they need transport to

At the processing facilities the tantalum and any other valuable non-radioactive elements are extracted, while all the radioactive elements are disposed of in residues or waste.

The transport mode will generally be road and sea, however air transport is sometimes used when there is no sea route available. The availability of sea routes for Class 7 transport has been diminishing as the maritime carrier industry has been contracting, with shipping lines being bought up or joining into fewer and bigger groups, and generally adopting the most restrictive policies of the individual members. While air transport is quicker, simpler and more reliable, it has the drawbacks of often being more expensive than is economically viable, and having a much greater carbon footprint.

Figure 5: The majority of tantalite shipments are made in ocean-going containers: (left) tantalite in drums, on pallets, loaded in freight container on a truck, and (right) an ocean-going container ship (photos: T.I.C. and Shutterstock)

The total gross quantity of tantalite raw materials transported annually is of the order of 10’000 mt (containing the 2'000 to 2'500 mt of Ta metal equivalent mentioned above), or a minimum of 500 freight containers each carrying 10-20 mt of material. Much of this would require transport as Class 7 radioactive material (in accordance with IAEA SSR-6, IMDG Code Class 7, and others as applicable), and where the radioactivity concentration is below 10 Bq/g the material would be exempt from transport regulations for radioactive materials and could be transported as general cargo.

Transport method

Tantalum raw materials are typically shipped by sea as a dry mineral (<0.5% moisture) with a grain size below 5 mm, typically packed in new steel drums with separate lids held in place by a steel band, or alternatively in recycled metal drums, plastic drums, or simply in new or recycled 1 mt bulk bags, or 50 kg plastic bags. The material may even be stowed unpackaged in a freight container, with the container acting as the packaging, with an interior liner to prevent material loss.

If sent by air, the material will be packed in new steel drums with an inner liner, and each drum may then have a custom made crate built around it to prepare it for transport.

Due to the density of tantalite, a 20 mt shipment of tantalite will not fill the entire volume of a freight container. Sometimes smaller shipments of 10 or 15 mt are made.

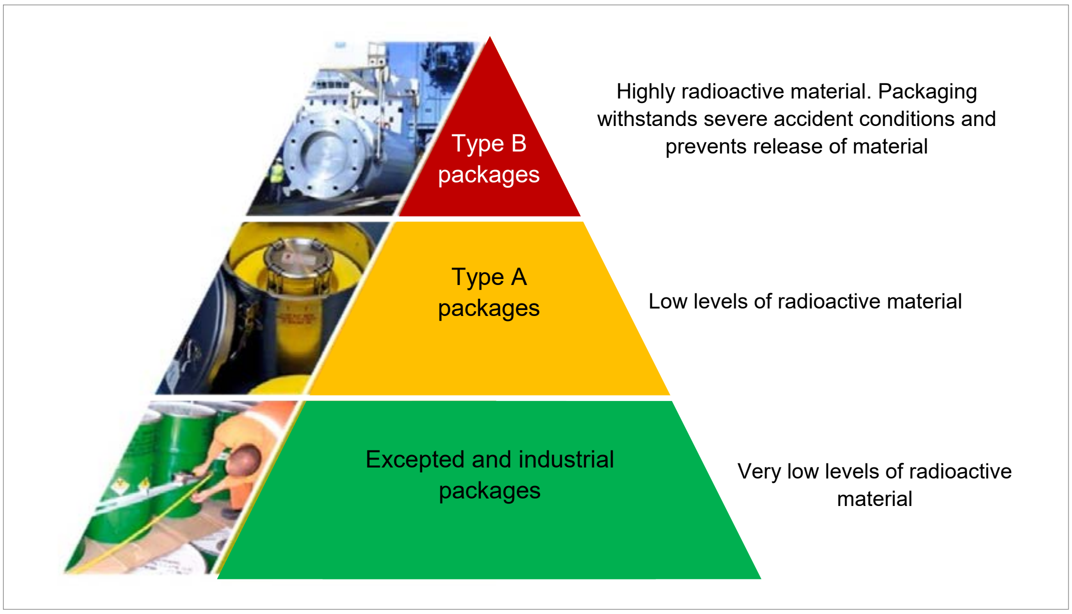


Figure 6: The types of packages used to transport Class 7 materials are graded according to the type, amount and nature of the radioactive material. This ensures an appropriate level of safety is always in place (Image: World Nuclear Association)

Denial and delay examples

For a delay or denial of shipment to exist, the material to be shipped would meet all applicable transport requirements for radioactive materials.

Despite Class 7 being a premium product commanding a premium freight charge, the increased fee is far less than the financial cost of a delay or rerouting. Further, the transport of Class 7 (radioactive materials) suffers from a problem with its image, the perception often being that these materials are somehow inherently more dangerous than other classes of dangerous goods (explosive, flammable, oxidising), whereas in fact the transport of radioactive materials has an excellent and enviable safety record.

From recent enquiries across the entire tantalum industry, the ability to transport Class 7 has not improved, and is now clearly more difficult than when the T.I.C. first began fact finding on this issue in 2004. The identity of respondents has been kept confidential, however the types of delays and denials are discussed below.

The difficulties arise principally in obtaining carriage.

Obtaining carriage

When a company attempts to obtain carriage for tantalum raw materials above 10 Bq/g, the response from maritime carriers falls into one of the following categories: no response; blanket refusal; non-recognition of excepted package; exorbitant quote for carriage with no guarantee of delivery. All of these responses are valid and permissible commercial decisions, and we need to look deeper to find their root cause.

- No response

The carrier simply does not reply to enquiries requesting quotes for carriage of tantalum raw materials.

- Blanket refusal

The carrier refuses to accept any tantalum raw materials, regardless of their radioactivity concentration.

- Non-recognition

The carrier does not recognise the status of exempted (<10 Bq/g), or UN 2910 (Excepted Packages), where applicable, and insists all tantalum raw materials must be declared as UN 2912 (Low Specific Activity I). This particular issue began occurring around 2017 and has become entrenched with a number of carriers.

- High fees, no guarantees

The carrier will quote a fee typically 5-10 times greater than the normal rate. Despite this, no guarantee of delivery is provided, as the carrier will reserve the right to offload the Class 7 container at any port along its route should it choose to do so, and the consignor would then have to attempt to rearrange onward transport as a new booking.

With some carriers, their response is systematic and will de facto not accept Class 7. A few carriers will accept Class 7 tantalum raw materials if their end destination is the carrier's home country, or shepherded by a trusted logistics brokerage.

Geographically, the difficulties arise most often on routes from eastern Africa to Europe or the USA, for example in one instance when the Suez Canal denied passage to a container with Class 7, it necessitated a maritime journey of 12300 nautical miles via South-East Asia followed by a road journey of over 4300 km, instead of the more direct route of 8400 nautical miles via the Suez Canal, plus a mere 100 km by road to reach its destination.

Similar examples exist elsewhere, and are due to not being able to obtain carriage by the most efficient and cost-effective route.

As a trend, the situation has been worsening and it is harder than ever to transport tantalum raw materials, for all the reasons listed above.

Figure 7: The logos of the Transport Facilitation Working Group (TFWG). The T.I.C. is a member of this multi-stakeholder group which proposes strategies and activities necessary to facilitate the safe and secure global transport of radioactive materials, and to contribute to their implementation. (Image: TFWG)

- Carrier justification

Why do carriers respond in this manner? There are several reasons, one of which is increased risk to their business. For example a vessel carrying as little as one container of Class 7, may unexpectedly be advised by the next port that it will not be allowed entry due to the container of Class 7, thus requiring a rerouting that may incur additional costs in excess of $500k, that may be as much as 10 or 20 times or more the shipping rate charged for that one container, due to the need to offload and reroute a great number of containers, plus potential penalties for late delivery.

- Root cause

The difficulty for carriers arises from ports and local authorities, or national regulations that are incompatible with those of another jurisdiction along that transport route, or due to sudden decisions taken once the ship is already en route.

States have the sovereign right to set regulations as appropriate and necessary for their particular jurisdiction. What there needs to be however is greater awareness of the impact of having regulations that differ or vary from international regulations. There needs to be co-operative communication between authorities at all levels for there to be better awareness of the impact of regulations, and coordination to minimise duplicative, overlapping and sometimes contradictory requirements. There needs to be consistent application of regulations, with any changes being applied after a transition period in order to enable carriers and industry to adjust and adapt, and not with immediate effect, potentially causing great disruption, cost, and increased risk to the safety and security of Class 7 shipments already on the high seas.

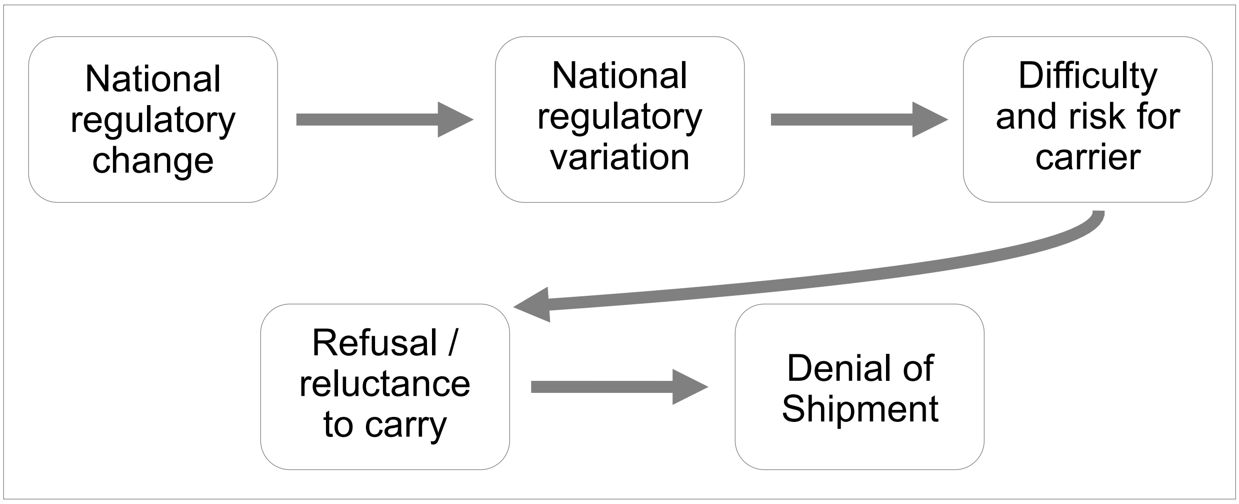


Figure 8: How regulatory variations can be root causes of denial of shipment

<u>Recent developments</u>

On a few routes, it is still possible to transport tantalum raw materials as Class 7, particularly with national carriers to their key domestic market. In this context the continued support for Class 7 exists with close communication between the receiving processing facility, the national and/or local authorities, and the national maritime carrier.

However as a result of the increasing difficulty or complete impossibility in obtaining carriage for Class 7 on a number of key routes, in recent years there are three major developments that have taken place:

1) Whereas most tantalum raw materials have Th+U radioactivity concentrations in the 5-50 Bq/g range, it has become almost ubiquitous to either:
    a) Blend high and low grades of minerals down to below 10 Bq/g in order to be able to transport as general cargo, with a loss of efficiency and payable content and higher carbon footprint;
    b) Blend valuable mineral with worthless sand or gravel down to below 10 Bq/g in order to be able to transport as general cargo (as is perfectly permissible if uniformly blended), with a loss of efficiency and payable content and higher carbon footprint;
2) Transport smaller tonnages as Class 7 by air freight. Class 7 transport by air freight is less subject to unexpected denials en route and therefore presents less financial risk, is of course much quicker, but at greatly increased cost and carbon footprint, partially offset by the opportunity to send tantalum raw materials with as high a valuable concentration as possible, and radioactivity concentrations that may exceed 50 Bq/g;

3) UN 2910 (Excepted Package) is often not recognised or accepted, and carriers will insist on UN 2912 despite a package conforming to UN 2910. Excepted Packages could fulfil a very useful role as an intermediate level of regulation, however this is difficult to achieve for large freight containers and is hampered by a lack of recognition.

While the above developments are examples of how stakeholders will find ways to adapt to regulations, it is unfortunate in that these represent less efficient ways of obtaining transport.

Figure 9: Three recent developments: blending, airfreight and excepted packages

Unintended consequences

- Finding alternative ways to transport

The current difficulty in obtaining transport can lead to unintended consequences. It is understood that certain stakeholders (outside of the T.I.C. membership) feel that they no longer have a legitimate outlet for their mineral export and would need to close their mines, lay off hundreds of workers, thereby impacting the thousands of people who depend on that economic activity for their livelihood.

Faced with this situation, and possibly with the acceptance or even support of their national authorities that would rather see the economic activity continue, these stakeholders could find creative ways to circumvent the international regulations and avoid declaring material above 10 Bq/g as Class 7, something that in turn would be accepted by the consignee and the authorities at destination in order to protect that supply route.

They could be seen as bilateral or multilateral agreements as allowed for in regulations, however these would be informal arrangements outside of the transport regulations. It could potentially impact the safety of workers along the supply route.

If the existing framework of transport regulations that apply to minerals unintentionally happens to stifle transport and trade, to the point where certain national authorities would unofficially allow materials to be exported or imported without being declared as radioactive material, it surely would put into question whether the framework was fulfilling its intended purpose of ensuring safe and secure transport of all radioactive materials.

For the avoidance of doubt, let it be clear that no T.I.C. member is known to ship material >10 Bq/g without declaring it, and that such activity would be in clear breach of the T.I.C. Transport Policy as well as being a serious offence against the transport regulations and any applicable national regulations.

- Reassessing the implementation of transport regulations

What is really important is to understand that while the transport regulations present a framework that is technically sound and has been developed over more than 60 years and with an enviably excellent safety record, they are however not being implemented uniformly. This is known and accepted and allowed for as a sovereign right.

The variability in regulations this creates, leads to an environment of uncertainty and great financial risk to the carriers, consignors and consignees concerned. This risk is leading to fewer and fewer carriers that will accept to carry Class 7 material, particularly so as the maritime carrier industry has been coalescing and consolidating into fewer and bigger groups with a consequent streamlining of their policies, a streamlining that has tended to oust some working practices such as the acceptance of Class 7.

This is contributing to a situation where hundreds of mine workers and thousands of their dependents are threatened with a loss of livelihood, and this risks pushing people into non-compliance.

- Winners and losers

If every destination country followed the transport regulations, there would be no opportunity to misdeclare Class 7 cargo, there would be nowhere to send it, as it would simply be returned to origin. However all it takes is for one major country to allow for undeclared material >10 Bq/g to arrive at its ports and move smoothly on to the consignee, and suddenly there is an outlet. Material >10 Bq/g has a route to market under the radar, and this distorts the market in favour of the recipient country as it can receive high grade material at general cargo rates. The rest of the world labours with the restriction of having to blend down and transport low grade material, or taking a great risk in attempting to transport Class 7 correctly.

We need to ask ourselves what the solution to this is, whether it is a bigger stick to beat the poor miners with (particularly as these are primarily in developing countries that already have limited employment opportunities), naming and shaming the recipient country accepting misdeclared cargo, or a thorough reassessment of how uniformly the transport regulations are applied so that companies may confidently ship Class 7 material again, and carriers will willingly transport it.

<u>Potential solutions</u>

During the existence of the International Steering Committee on Denial Of Shipment (ISC-DOS) from 2006 to 2013, an action plan existed that was based around six key areas: awareness, communication, economic, harmonisation, lobbying and training.

- **Awareness** will always be needed, as staff changes and competing priorities at every point along a supply chain necessitate reminders of the denial of shipment issue, its impact, and the importance of keeping radioactive materials moving in a safe, secure and sustainable manner.

- **Communication** is the means with which we achieve Awareness, as well as all the other points of the action plan. The ISC-DOS prepared a detailed and excellent communication strategy that would still be valid today in showing how best to communicate with which target audiences.

- **Economic** is the argument for sustainability, for a low carbon footprint, for maintaining the economic activities without which there would be nothing to regulate.

- **Harmonisation*** is often understood in the IAEA transport community within the narrow meaning of reconciling IAEA regulations with those of other UN organisations. Harmonisation has to mean much more than this, it has to mean the encouragement of national, regional and local authorities to reconsider the regulatory variations that exist, to facilitate the discussion between authorities at different levels, within regions and between regions, to really understand the impact of such variations, and cooperate on mutually beneficial solutions.

- **Lobbying** is simply an element that binds the others together, it is the raising of awareness, the initiation of communication, the arguing for the economic impact, for harmonisation, and for training.

- **Training**, like awareness, will always be needed. New staff need starter training, other staff need continuous professional development and refresher training. Training is the step by which simple awareness is turned into real technical knowhow and a deeper understanding.

All six of these areas still have a relevance today, with awareness and training being top priorities, communication and lobbying being two means to achieve this, and harmonisation and a positive economic impact being ideal goals to attain.

* As reported in Bulletin #180, #182 and #184, currently the T.I.C. is part of the NORM Exemption Group within TRANSSC (the IAEA's committee responsible for reviewing and revising the regulations for the transport of radioactive material) at the International Atomic Energy Agency (IAEA). This group is charged with examining the regulations that apply to the transport of NORM. The work of this group centres on examining the differences in the exemption provisions between the 'new Basic Safety Standards' (General Safety Requirements Part 3 (GSR Part 3)) and the transport regulations (Safety Standards Series 6 (SSR-6)). [GSR Part 3 is one of the core IAEA regulations which other IAEA regulations should be consistent with]. The group is also checking for inconsistencies in the guidance that comes with the transport regulations (SSG-26) too. The transport regulations are unique and written in a different way to the new Basic Safety Standards because they deal with a particular activity that has specific requirements. Over time this has resulted in several inconsistencies appearing between the two sets of regulations, for example there is a particular clause in GSR Part 3 relevant to NORM which is not applied to transport of radioactive material in bulk, but most experts agree probably should apply. This is a rare opportunity to reconsider how best to regulate global NORM transport and the T.I.C. will endeavour to keep members and stakeholders informed of opportunities to provide their support so that the IAEA's working group can reach the best possible decision. Further information is available on the T.I.C. website www.tanb.org.

Specific recommendations

1) Reactivate and support regional networks, whether led by existing regional organisations such as the European Union, UNECE, or MERCOSUR, or where no suitable organisation exists, supported by the IAEA;
2) Reactivate the network of National Focal Points, that have worked so well in multiple countries, in providing a single point of contact for issues related to DOS to be discussed, coordinated and resolved (as called for in IAEA General Conference resolutions of 2019 and 2020);
3) Ask each member state to provide the IAEA, in addition to its competent authority for transport, with a list identifying the variations in national regulations from those of the IAEA and modal organisations;
4) Encourage each member state to allow transit and transshipment of Class 7 goods destined for other states, as being in the mutual interest of states in the region;
5) Review the implementation of transport regulations in the maritime mode, in co-ordination with authorities and maritime carriers, with a view to identifying inconsistencies and minimise duplicative, overlapping and sometimes contradictory requirements that represent obstacles to transport;
6) Harmonisation to enable more universal alignment of ports/countries with the IAEA regulations, thereby keeping the market open to everyone, benefiting the countries exporting material and industry overall;
7) Maintain transport and denial of shipment clearly included in training courses for stakeholders in transport.

……..

Postscript: Action points from the IAEA Technical Meeting on Denials of Shipment held online from March 23rd to 26th 2021

The panelists of the IAEA Technical Meeting on Denials of Shipment (photo: T.I.C.)

The meeting was constructive and productive, diving deeply into the causes and consequences of DoS, revealing both the extent of the problem and the scale of the challenges in overcoming the circumstances. There was unanimous agreement that while DoS was thankfully rare, when it occurred the consequences were often far-reaching and costly.

It was noted that the Covid-19 pandemic has brought the issue to a head, since ~80% of the global passenger aircraft fleet has been grounded and this has considerably increased the difficulties in shipping Class 7 by air. To give context to the issue it was estimated that over 15m packages of radioactive materials are shipped internationally each year. The vast majority of these are smaller than container-sized and are transported by air, usually as cargo on commercial passenger flights.

Looking ahead, there was a broad consensus among the delegates representing national regulators and industry that dealing with this problem cannot be postponed indefinitely. As such, it was agreed that a new IAEA-supported Working Group will be created to consider the options for addressing denials of and delays in shipment, including a code of conduct on facilitation, in line with IAEA General Conference resolution GC64/RES/9/81.

The T.I.C. strongly supports this course of action. We have already applied to join the new Working Group on DoS and expect to play an active role in its activities later this year. We shall keep members and stakeholders informed of future developments on this issue as and when they occur. TIC

EU and UK Conflict Minerals Regulations

The situation in the EU

On January 1st 2021 a new law came into full force across the EU - *the Conflict Minerals Regulation (EU) No. 2017/821* - which aims to control the trade in tin, tantalum, tungsten and gold (3TG). The regulation requires all importers to the EU of any of these four elements in quantities of over 1000 kg per year to register their company and undertake due diligence on their supply chain in line with the OECD's *Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas*[1] *('Guidance')*.

It is estimated that the regulation applies directly to between 600 and 1,000 EU importers and will indirectly affect about 500 smelters and refiners of tin, tantalum, tungsten and gold, whether they are based inside the EU or not. There is a wealth of supporting information about how to comply with the regulation, including the EU's own website[2] and from the European Partnership for Responsible Minerals[3] (EPRM) (of which T.I.C. is an active member).

For an importer of 3TG into the EU there are five steps of due diligence (taken from the OECD's Guidance).

The steps require an importer to:

- establish strong company management systems;
- identify and assess risk in the supply chain;
- design and implement a strategy to respond to identified risks;
- carry out an independent third-party audit of supply chain due diligence; and
- report annually on supply chain due diligence.

As the tantalum industry is well aware, at its simplest the term 'due diligence' means acting with reasonable care and investigating an issue before making a decision. In other words, it is an on-going, proactive and reactive process through which companies put in place systems and processes to make sure they are able to identify, manage and report on risks in their supply chain.

Companies buying 3TG minerals must check that what they buy is sourced responsibly and does not contribute to conflict or other related illegal activities. Companies continuously assess the likelihood that raw materials in their supply chains could be financing conflict, forced labour or other risks set out in the regulation. By checking their supply chains, they can then make sure that they manage those risks responsibly.

The situation in the UK

In one area of the UK, Northern Ireland, the EU regulation is legally binding; when the UK recently took itself out of the EU ('Brexit') a withdrawal agreement was signed between the EU and the UK which led to Northern Ireland remaining in the European Union Customs Union and European Single Market while also being part of the UK.

This interesting arrangement avoids the need for a 'hard' customs border on the island of Ireland, but as a result, any company importing 3TG into Northern Ireland must comply with the EU Conflict Minerals Regulation in full.

In all other areas of the UK the EU Conflict Minerals Regulation is not enforceable and companies may continue to operate as before, which the British government somewhat optimistically describes as "voluntarily complying with the OECD guidance"[4]. The British law enforcing this situation is the *Conflict Minerals (Compliance) (Northern Ireland) (EU Exit) Regulations 2020*. Government sources, speaking unofficially to the Bulletin, expect that a regulatory system for 3TG in the rest of the UK will be considered by the Foreign, Commonwealth and Development Office (FCDO) in the future, but couldn't say when this process would start or how any new regulation might work.

Map showing Northern Ireland (red highlight) (Picture: Google Maps)

The FCDO will publish further guidance for businesses in scope of the regulations "as soon as possible in 2021", according to their website, but until then companies can contact the UK's Conflict Minerals National Competent Authority at the FCDO on CMNCA@fcdo.gov.uk.

Further information:

1 - OECD's due diligence guidance https://www.oecd.org/corporate/mne/mining.htm

2 - EU's official guidance https://ec.europa.eu/trade/policy/in-focus/conflict-minerals-regulation/regulation-explained/index_en.htm

3 - EPRM's Due Diligence Hub, which the T.I.C. helped to develop, is at https://europeanpartnership-responsibleminerals.eu/cms/view/53241995/due-diligence-hub

4 - The UK's guidance for importing 3TG into Northern Ireland https://www.gov.uk/guidance/importing-conflict-minerals-into-northern-ireland

Interview: Rashad Abelson, OECD legal expert for supply chain due diligence / responsible minerals

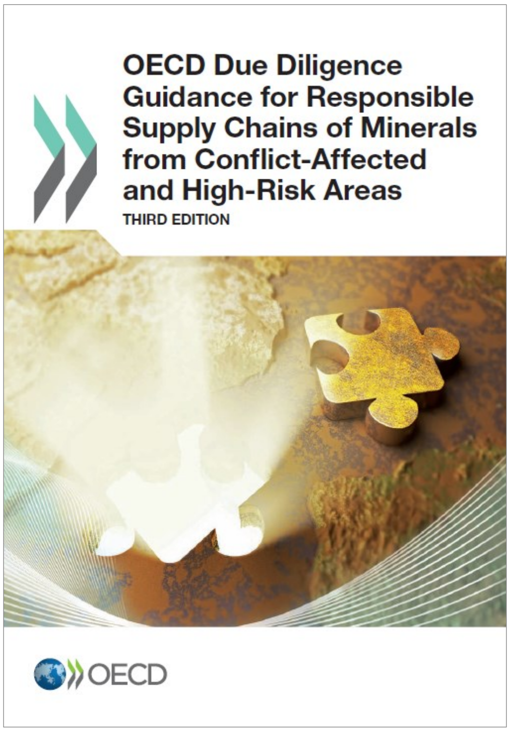
Rashad Abelson is a legal expert working on the Responsible Minerals Implementation Programme in the OECD Centre for Responsible Business Conduct based in Paris, France. His work includes monitoring of government implementation of due diligence commitments and relevant legislative developments, fostering law enforcement cooperation on minerals related crime, and developing research tools on risks in mineral supply chains.

Here Rashad Abelson (RA) is interviewed by T.I.C.'s Roland Chavasse (RC) about the OECD's forthcoming report titled *Cost Sharing and Value of Implementing Supply Chain Due Diligence*. The report will be launched on 28th April during the 2021 Forum on Responsible Mineral Supply Chains.

RC: Rashad, thank you for making time to talk to the Bulletin. The OECD *Due Diligence Guidance for Responsible Mineral Supply Chains* ("Guidance") is the global benchmark advice to help companies respect human rights and avoid contributing to conflict through their mineral purchasing decisions and practices. Initially published a decade ago the Guidance is currently in its third edition. Rashad, what is the feeling among your colleagues as to whether it achieved what it set out to achieve?

RA: Thank you for chatting with me and for highlighting our work. The main objective of the Responsible Minerals Implementation Programme is to promote broad adoption and usage of the Guidance. This includes working with OECD and non-OECD governments to fulfil their commitments and adopt the standard in a coherent way, and working with private sector and civil society to highlight and help resolve new issues through targeted research, development of tools, organising awareness raising events, and conducting trainings. Reflecting back at the developments of the last ten years, while there is still a lot more work to be done, I think we can definitely say the Implementation Programme has been a success.

Since 2011, we've seen the adoption and implementation of an array of responsible sourcing legislation (in the United States, European Union, Switzerland, United Kingdom, Democratic Republic of Congo (DRC), Uganda and Rwanda), industry requirements in gold, 3T, and other base metals, and company commitments increasingly covering more mineral supply chains (e.g. copper, cobalt, mica, coal, etc) and more geographies (India, China, West Africa, and Latin America).



The Guidance can be downloaded at www.oecd.org/corporate/mne/mining.htm. The most recent edition is the third edition (2016)

What began as a piecemeal effort focused on specific regions or metals has now grown into a larger interconnected picture, albeit with some gaps and the need for more consistent implementation efforts globally.

In fact, taking a more critical look at the state of play, uneven global implementation of the Guidance is likely one of the reasons why we're seeing smaller upstream actors located in conflict-affected and high-risk areas (CAHRAs) face particular difficulties getting their minerals to the market responsibly.

Essentially, for some supply chains, there appears to be a disconnect with the objectives of the Guidance (to promote greater market access of responsibly sourced material from CAHRAs) and the reality of the market (accessing the market responsibly from CAHRAs may require high investments in due diligence efforts). That being said, the costs of doing business responsibly are simply the costs of doing business. Responsible business conduct should be the norm, rather than the exception.

RC: Is this one of the key findings in the new report?

RA: Yes it is. On-going discussions in multi-stakeholder forums have raised important questions on the perceived imbalance of how due diligence costs and benefits are distributed along the supply chain. Governments, private sector representatives, and civil society organisations participating in the Implementation Programme have been involved in discussions for over three years.

The OECD Secretariat wrote this position paper to inform discussion on this topic by giving stakeholders a better understanding of how the costs of due diligence are currently distributed and how they can potentially be differently distributed across the supply chain, appropriately recognising the value and benefits of due diligence.

RC: What was the objective of this work?

RA: The overall objective of this work was to establish a common understanding on key issues and use that common understanding, plus the OECD's role as a global convener, to facilitate targeted discussions and direct stakeholder support with a view to achieving a sustainable resolution.

RC: Could you elaborate about some of the other topics that the report discusses?

RA: This paper acknowledges that while downstream supply chain actors certainly face significant due diligence costs themselves, smaller upstream supply chain actors appear to face sizeable commercial constraints, often associated with limited liquidity, small margins and higher costs of doing business.

Current market dynamics exacerbate existing challenges for upstream actors trying to do business responsibly. The paper observes that smaller upstream actors, particularly in CAHRAs, have higher burdens to demonstrate more extensive due diligence measures. Many market actors are reportedly either avoiding ASM and CAHRA-linked minerals or paying premiums for minerals from low-risk regions. On top of that, many market actors are also reportedly accepting "due diligence-free" minerals at an equal or lower price (or in the case of gold, at a higher price due to its use as a vehicle for money laundering). All of which distort incentives to conduct due diligence.

Added to that is the apparent difficulty to reflect the value and benefits of carrying out due diligence activities in the prices paid between parties to a transaction. As minerals are refined and smelted, and eventually enter downstream supply chains as small parts of larger components, their relative value becomes an increasingly smaller share of the overall value-added activity in downstream segments of the supply chain; hence some due diligence benefits enjoyed by downstream actors, while important in aggregate, are less directly attributable to specific upstream activities. The paper gets into a detailed discussion on the costs and benefits of due diligence for different segments of the supply chain. Currently, efforts to support broader economic development and due diligence-specific programmes exist such as the European Partnership for Responsible Minerals and the Public-Private Alliance for Responsible Minerals Trade for example. However, governments, development agencies, donors, and downstream companies need to do more to support both on-the-ground due diligence efforts and regulation of minerals supply chains.

The OECD hosts the annual ICGLR-OECD-UN GoE Forum on Responsible Supply Chains. Usually this is held at its headquarters in Paris, France, but this year the event was held online. (Photo: T.I.C.)

More substantial support is needed in the form of financial support to on-the-ground technical assistance, which could help reduce costs for responsible supply chain actors. Likewise, stronger enforcement can make doing business irresponsibly less economically viable. This type of support can help bridge the aforementioned disconnect between the objectives of the Guidance. Supporting capacity building and technical assistance for governments in mineral producing regions, particularly with regards to customs and law enforcement, can have positive long term benefits for markets. Enforcement institutions (including industry-led self-regulatory bodies) play a critical role in combatting illicit mineral trade and activities such as smuggling, tax evasion, fraud, and conflict or terrorist finance. Developing mineral producing government capacity can help reduce the cost of mitigating and preventing risks in CAHRAs (e.g. through reduced mine-site and transportation security costs, less unfair competition from illicit actors, greater trust from buyers, and easier stakeholder engagement) and conversely increase the cost of illicit activities, thereby increasing market access for responsibly sourced goods.

RC: Thank you for your time, I look forward to reading the report shortly on the OECD website*. TIC

* at time of print the link was not available, but it will appear at the bottom of the main Responsible Minerals Implementation Programme webpage at https://mneguidelines.oecd.org/mining.htm and also be featured as a news item on the T.I.C. website www.TaNb.org.

Next generation niobium-bearing reinforcing bar steels for construction of resilient buildings and infrastructure

Paper written by Steven G. Jansto Ph.D., Principal Partner at Research and Development Resources and a CBMM Technical Consultant working on behalf of CBMM North America, Inc. Copyright © CBMM.

This article was first published on www.niobium.tech.

Executive summary

Weldable and non-weldable reinforcing steel bars are among the most important steel products applied in civil construction. The available strength level of niobium (Nb)-bearing rebar has been increased with the 345, 390 and 490 MPa family of grades in addition to positive developments in the 600 MPa series. Traditionally, higher strength grades were produced with vanadium and/or various controlled cooling processes. However, recent mechanical property and microstructural heterogeneity issues have led to increased global production of Nb-containing reinforcement bar products of all diameters. The combination of clean steelmaking practices at the melt shop with selective furnace heating practices, as well as controlled cooling practices at the rolling mill, are major operational focus areas.

Production practices relating to lower carbon equivalent construction-type, earthquake and fire-resistant steel rebars from the melting stage through the crack-free continuous casting of the billets and extending through hot rolling and strategic cooling steps are critical. Specifically, the practices maximize the effectiveness of Nb when manufacturing high quality, high strength reinforcing bar grades.

The step-change trend in rebar production is the design of cost-effective lower carbon, lower residual contents (including sulphur and phosphorous), reduced nitrogen, lower manganese and more homogeneous microstructure replacing traditional mixed care/shell rebar. Adaptation of these product characteristics can be cross-applied into lower strength non-earthquake/fire-resistant rebar, thereby reducing operational cost per ton and improving product quality for the end user in addition to reducing scrap rates during construction.

In 2019, the American Concrete Institute (ACI) Building Code Requirements for Structural Concrete introduced several new seismic design and material property requirements for higher strength steels in its ACI 318-19 release.
These updates are expected to support adoption of high strength rebar, which will reduce congestion in heavily reinforced members, improve concrete placement, and save time and labour.
It is anticipated the key changes of ACI 318-19 will be referenced in the 2021 International Building Code (IBC).
(image: Shutterstock)

Key takeaways:

- Building and infrastructure design has been undergoing a transformative period fuelled by heightened awareness of seismic activity, extreme weather events, and blast and fire episodes. In addition to occupant and user safety, the enormous financial risks to governments and insurers are driving demand for better performing concrete reinforcement for new resilient building construction and retrofits of existing structures.
- Rebar and long product producers are uniquely positioned to develop new product grades featuring exceptional properties by implementing the successful microalloy process strategies popular today in other markets, notably high strength and high toughness automotive, pipeline and critical structural applications that include beams, forging quality bars, ship plate and pressure vessels.
- Attaining high strength and toughness for next generation rebar applications requires clean steel practices that significantly reduce sulphur and phosphorous, and control residual levels. A two-step strategy involving niobium (Nb) is recommended.
- A growing trend in rebar production is a design comprised of cost-effective lower carbon, lower residual contents that include sulphur and phosphorous, reduced nitrogen, Nb-containing lower manganese chemistries and a more homogeneous microstructure that replaces traditional mixed core/shell rebar.
- Minimizing strain gradients are an effective approach to reducing the cooling rate during hot roll processing. This process lowers the risk of sub-surface cracking, especially under fatigue and bending states that can occur in the highly mixed microstructure between the shell and core zone.
- The material properties and value add of next generation Nb-bearing reinforcing bars enhance the competitive advantage of steel products as a more suitable solution for design builds that must factor seismic, extreme-weather and fire resistance in concrete reinforcement.

About 40 percent of the world's population (nearly 2.4 billion people) lives within 100 km (60 miles) of the coast. Coastlines are vulnerable to high wind events – and in seismic zones – the interrelated hazards of earthquake, landslide and tsunami. As the population continues to migrate toward the coastlines, the civil engineering sector is looking for concrete reinforcement that adds to the resiliency of buildings and infrastructure. (image: Shutterstock)

Introduction

The compelling need for the development of even higher quality rebar for seismic applications is driven by catastrophic earthquakes that have occurred in several countries including Haiti, Mexico, Peru and China combined with the climatic impact of hurricanes and tornadoes in the United States.

Rebar research projects are being conducted worldwide. The focus continues to be on developing a family of Nb-containing reinforcing bar, including S500 and S600 grades with superior toughness, fatigue resistance and less yield-to-tensile variation. A successful high-quality production of these higher strength-elongation steel grades, regardless of the microalloy addition type, requires changes in melting and hot rolling practices. Such production leads to the consistent manufacturing of these value-added S500 and S600 reinforcing bar grades for earthquake, hurricane and typhoon resistant applications.

Rebar and long product producers should consider implementing the successful process strategies being used today in high strength and high toughness automotive, pipeline and other critical structural applications such as beams, forging quality bars, ship plate and pressure vessels. Cross-application of these grade designs, process metallurgy steelmaking and hot rolling practices are extremely valuable, especially when involving the manufacture of high quality, high strength seismic and fire-resistant rebar. Additionally, several of these cost-effective improvements in chemistry, melting, casting and hot rolling can be incorporated into rebar production for grades as low as S235.

Global rebar user market and product demands from steel producers

The market trend for an improved reinforcing bar in seismic grades and hurricane/typhoon regions is driving the development of new product grades featuring exceptional properties not available in currently manufactured reinforcing bars.

Next generation Nb-bearing rebars are focused on properties with the following characteristics: (1) improved energy absorption at both ambient and extremely low temperature; (2) higher yield strengths for reduced cross sections; (3) higher elongations; (4) better weldability to reduce construction time; (5) improved heat-affected zone (HAZ) toughness; (6) better corrosion resistance; (7) improved elevated temperature properties; (8) improved seismic performance; (9) and better fatigue resistance. Those involved in the supply chain are demanding these property improvements for both weldable and non-weldable reinforcing bars.

Successful steelmaking production of value-added seismic rebar requires application of several melt shop and rolling mill practices that in some cases resemble melt shop procedures associated with producing value-added automotive, pipeline and structural grades. Tighter process control during the melting, casting, billet heating and rolling is necessary to meet the demanding properties required for seismic-prone environments, including reduced carbon, sulphur, phosphorous, nitrogen and residual levels (i.e. Cu, Bi, Pb, Sb, As, Sn). In the past, these practices were often considered unnecessary within the long product production sector of the global steel industry.

Adaptation of these more disciplined melt shop and reheat furnace practices already transcend weldable rebar production for nonseismic weldable reinforcement bars in some countries. However, future generation rebar products will demand changes in operational practices to accommodate customer requests. Otherwise, substitute rebar construction materials will be used.

Resources needed for recovery from a large-scale natural disaster often greatly exceed the mitigation efforts that preceded the disaster. Steel producers can develop value-added rebar solutions for seismic and fire resistance using the material property enhancements of niobium, already proven in high strength, high toughness automotive, pipeline and structural steels.

The threat of substitute rebar materials and the steel solution

Steel substitution has become commonplace over the past several decades. For example, an alternate rebar material substitution for steel could offer several options from the past, including: (1) resembling the impact of Al on steel container displacement; (2) numerous steel tubular products – among them conduit and pipe – replaced by plastic materials; (3) composite graphite power transmission components; (4) and simple high strength reinforced plastic and timber sections and shapes.

Steel producers need a strategy to combat these alternative material threats. Different control strategies are required for the production of high-quality construction steel rebar to further improve quality performance consistency and homogeneity from heat-to-heat. This step-change improvement creates a formidable obstacle to the threat of using substitute alternative rebar materials.

A specific strategic approach taken by some producers may include lower residual element levels, scrap segregation, lower sulphur and phosphorous levels, adopting a low carbon approach, control of nitrogen levels at the basic oxygen furnace (BOF) or electric arc furnace (EAF), and improved steel cleanliness at the tundish during billet casting. The new approach involves chemical elemental levels at significantly lower concentrations for C, N, S and P than identified in the ASTM A706 specification.

	C	Mn	S	P	Si	N	Nb
ASTM specification maximum*	0.30	1.50	0.045	0.035	0.50	N/A	N/A
Recommended chemistry	≤0.20	1.20	≤0.007	≤0.030	0.30	90 ppm EAF 60 ppm BOF	0.015-0.025

Table 1. Strategic world-class rebar approach
*Shown by heat analysis in ASTM A706-16

Carbon reduction can be executed in two stages, especially if a producer is currently near the 0.30% C level. N levels should be held to a maximum, but N is not part of the specification. Sulphur and phosphorous levels, in addition to the residual elements, can adversely affect fatigue, fracture toughness and ductility properties.

Next generation design criteria

Future changes will transition differently throughout the global rebar producing sector depending on a given rebar producer's objectives, mill capabilities, cost structure and overall commitment to external quality. Three criteria represent the cornerstones for these initial rebar changes.

They are: (1) reduced carbon for improved ductility and toughness; (2) control of steel impurities through reduced sulphur, phosphorous and residuals; (3) and homogeneous microstructure with only 10HV hardness variation from the rebar surface through the cross-section, leading to grain size uniformity (with Nb) and improved mechanical property consistency throughout the heat.

Integration of the process metallurgy with the rebar product metallurgy is essential during both the melting and hot rolling processes. [1]

Effect of carbon

The importance of carbon and its effect on ductility is well known among steel rebar producers. However, no consideration has been given to the indigenous effect of carbon on the impact toughness parameter for most rebar products since the impact strength typically is not part of the specification.

Nevertheless, impact strength through the thickness of a given product, even rebar, reveals an incredible amount of information concerning the product metallurgy of the bar. Figure 1 illustrates the relative differences in each steel as a function of carbon. Note the maximum allowable C content as shown by the heat analysis relating to ASTM A706 rebar for high strength, including earthquake-resistant applications, is set at 0.30% C.

Many producers of Grade 60, Grade 80 and Grade 100 rebar judiciously reduce the carbon content to a desired amount, but the levels are quite diverse and often not publicly reported. The maximum allowable residual phosphorous is 0.035%. Sulphur is 0.045%.

Deterioration in toughness (energy absorption of a given carbon steel grade) is significantly affected by increasing carbon levels. A challenge concerning rebar specifications is identifying the maximum allowable carbon content. For example, if a producer reduces the carbon content from 0.30% C to 0.20% C, the reduction results in a 33 percent improvement in energy absorption from 25J at 0^oC to 140J, nearly a six-fold improvement. Another 25 percent energy absorption improvement results if the carbon is lowered to 0.11%.

Control of steel internal cleanliness

Due to the competitive nature of the rebar market, the operational cost of reducing residual levels often is considered excessive. Yet, if one considers the total activity-based production cost, manufacturing steels are not as costly as commonly believed. The key is to measure the total activity-based cost of steelmaking throughout the entire process, including the customer's external cost to attain quality. [2] The example below provides a simple comparison of toughness improvement through a reduction in sulphur levels. Low sulphur and low phosphorous combined with strict nitrogen control significantly increase the probability of consistently producing high quality structural steels that exhibit superior fracture toughness and impact strength. Low sulphur and low phosphorous steels improve both the castability and toughness of the steel, thereby minimizing billet, beam and slab cracking. Improvements in the rollability of the steel by reducing thermal resistance to deformation during rolling also can be achieved.

Currently, there are extremely limited clean steelmaking practices applied to the production of high strength rebar throughout the world. As presented earlier, cross-application of process metallurgy practices applied to other products, such as pipelines, beams and ship plates to name a few, can be applied to seismic rebar production.

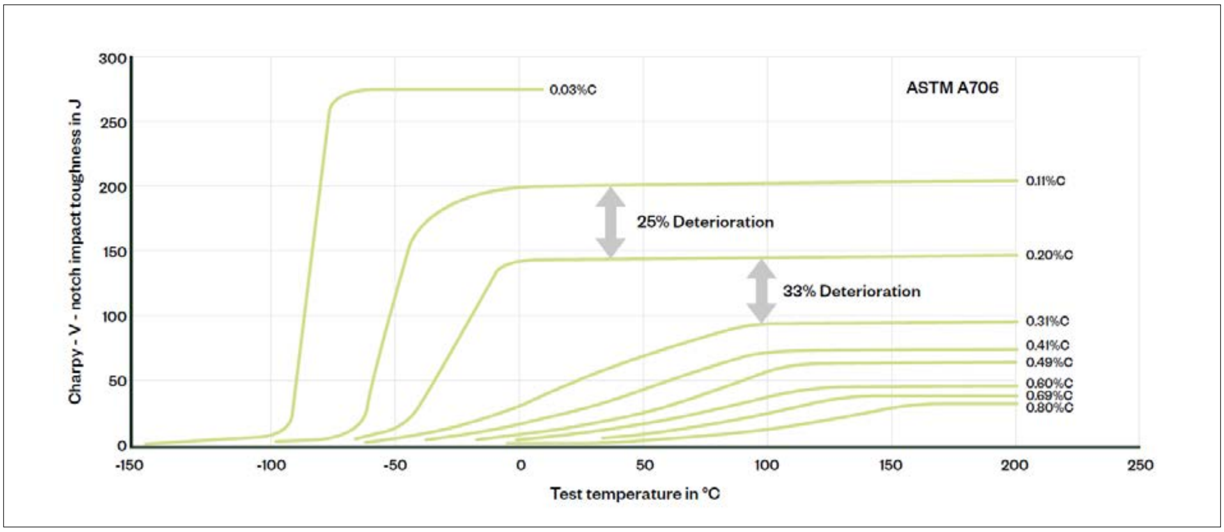


Figure 1. Impact toughness at temperature for various carbon grades [3]

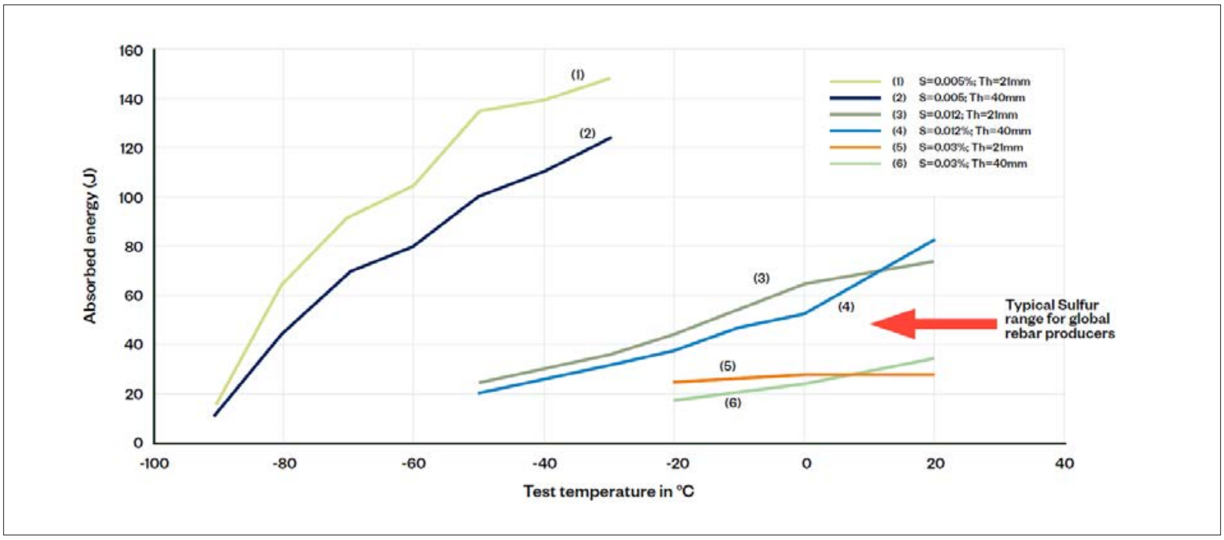


Figure 2. Sulphur effect on Charpy V toughness in transverse direction Grade 50 plate [4]

Figure 2 illustrates the toughness of S355 for construction plate applications at decreased sulphur levels.

Note that for each 50 percent reduction in sulphur, Charpy impact strengths are improved at least three to four times. Beyond accommodating the customer's need for improved toughness, the strategy for achieving a lower sulphur level also is aimed at meeting the internal operational need to reduce mill loads.

The benefits derived from finishing at low temperatures are well established. Again, some mills are unable to perform rolling at these temperatures due to load constraints placed on the mechanical drives and motors.

Homogeneous microstructure achieved through air cooling

The cooling scheme achieved through application of different water-cooling processes was developed several decades ago and has provided excellent performance over the years in meeting end-user needs. The TempcoreR process is applied to reinforcing bars as a way of increasing yield strength. It is a direct quench after hot rolling. [5, 6]

However, there are tradeoffs today in attempting to meet new end-user demands by incorporating the TempcoreR process for certain applications. Based on current demand for more consistent rebar from heat-to-heat, better ductility/bendability at increased yield strength and improved fatigue performance, it is recommended producers consider an alternative rebar processing approach. The goal is to obtain a homogeneous microstructure from the shell to the core of the rebar.

Water-cooled non-Nb and air-cooled Nb-rebar comparisons are made relating to their chemistry (Table 1), mechanical property data (Table 2), and microstructure (Figure 3). Stress and strain curves, including the derivation of the strain energy, are especially important.

	C	Si	Mn	P	S	Nb
Without Nb+H_2O	0.25	0.15	0.65	0.041	0.034	-
With Nb+H_2O	0.28	0.26	1.00	0.030	0.042	0.02

Table 2. Conventional water-cooled rebar and Nb-air-cooled rebar chemistry

Mechanical properties	Without Nb plus water	With Nb and no water
Yield strength (MPa)	620	600
Tensile strength (MPa)	752	828
Elongation (%)	10	13
Tensile/yield ratio	1.21	1.38
Strain energy (MPa-mm/mm)	65.19	91.17
Core to shell hardness variation through cross section (HV)	194-298	238-247

Table 3. Conventional water-cooled rebar and Nb-air-cooled rebar chemistry

The fundamental relationship between a more uniform homogeneous microstructure and consistent mechanical properties is well established. The mixed or heterogeneous microstructure, such as exhibited in Figure 3, is expected to result in great variability.

In addition, the interface between the shell and core zone is a highly mixed microstructure and susceptible to sub-surface cracking, especially under fatigue and bending states. This mechanism has been proven in other metallurgical research showing that a sub-surface mixed microstructure is the root cause of cracks that develop under bending conditions. [8]

The comparison illustrates that the Nb air-cooled rebar exhibits four key characteristics compared to the traditional water-cooled tempered martensite shell-bainite core mixed heterogeneous microstructure. They are: (1) 30 percent increase in elongation; (2) 14 percent increase in tensile/yield ratio; (3) 39.7 percent higher strain energy (i.e., energy absorption); (4) and more homogeneous microstructure.

This next generation rebar metallurgical approach is summarized in Figure 4.

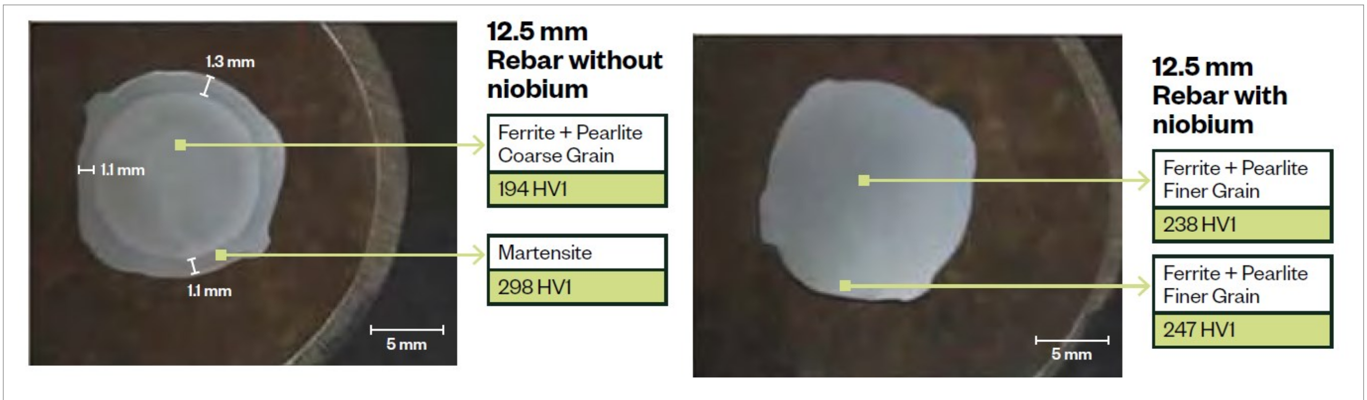


Figure 3. Water-cooled and air-cooled rebar comparison [7]

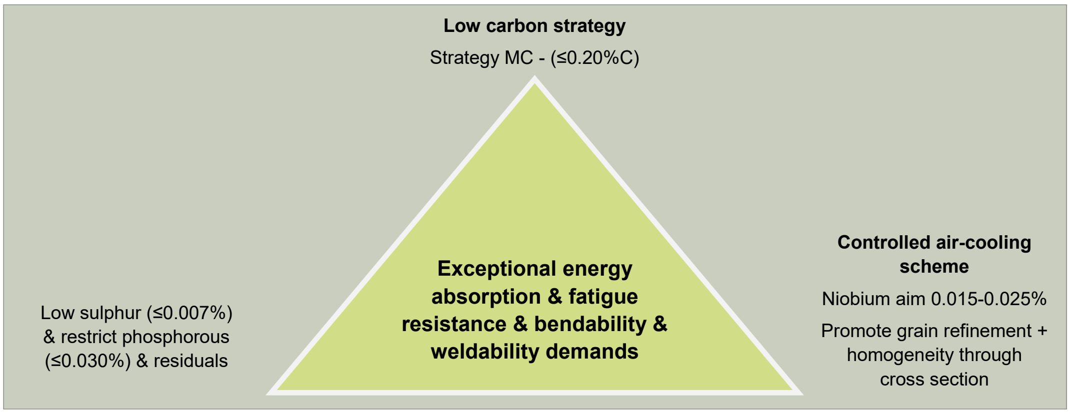
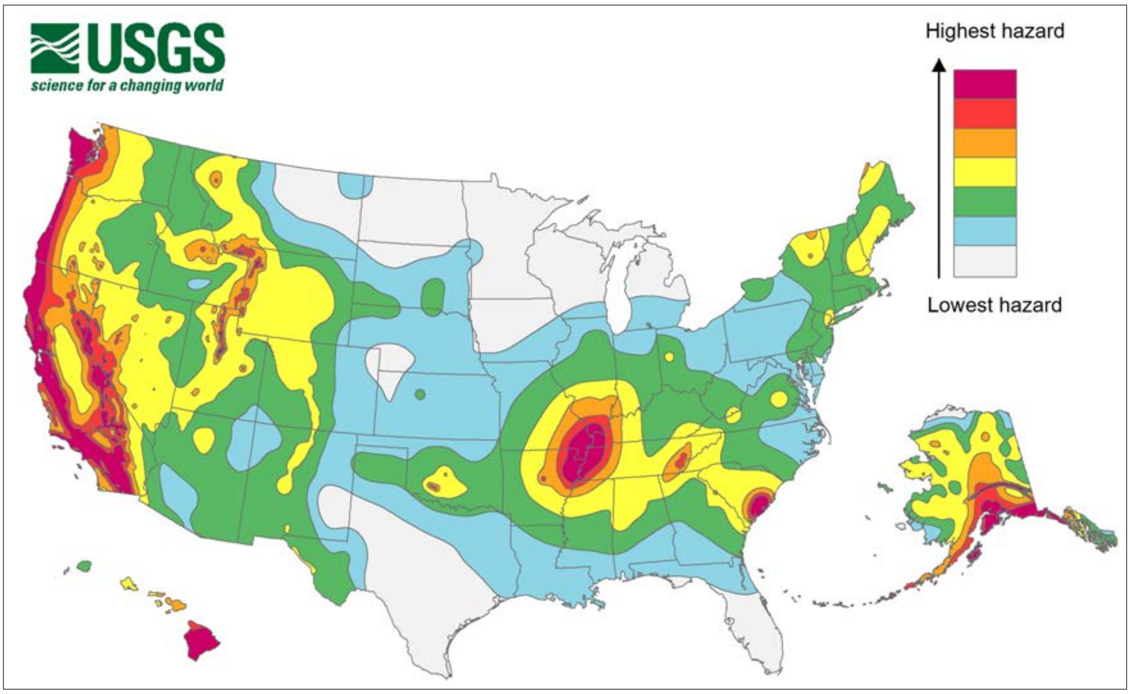


Figure 4: Next generation reinforcing bar process/product metallurgy priorities

Evolving Nb-bearing reinforcing bar for earthquake and fire-resistant applications [9]

Building on the next generation reinforcing bar, the compelling need to develop higher performance steels for seismic and fire-resistant steel applications is driven by recent catastrophic events, namely earthquakes and tsunamis.

Current research and development projects throughout the world are focused on developing a family of niobium/ molybdenum-bearing S500 and S600 grades of bar, beams and plates that possess superior toughness, fatigue resistance, fire resistance, seismic resistance, reduced yield to tensile ratio variation within a heat of steel, and overall superior performance.



In the United States, nearly half of the population is exposed to potentially damaging earthquakes, with various probability levels applied in seismic provisions of building codes, insurance rate structures, risk assessments and other public policy. Globally, one out of three people is exposed to earthquakes, a number that almost doubled in the past 40 years, mostly due to urbanization. (image: Credit: U.S. Geological Survey; 2018 Long-term National Seismic Hazard Map)

The engineered nucleation and controlled growth of complex nano co-precipitation containing Nb and Mo contribute significantly to a mechanism that results in enhanced performance under seismic and/or environmental conditions. Successful high-quality production of these Nb-Mo steels with higher strength elongation steel behavior may require slight process metallurgy adjustments to melting and hot rolling practices.

The adjustments are made to consistently manufacture and initiate the optimal precipitate size, distribution and volume fraction of Nb, Mo (C, N) in these value-added earthquake/fire-resistant grades.

Producers of rebar, long product and plate that plan to supply these applications should incorporate the successful processing metallurgy strategies and operating procedures being used today for advanced high strength and high toughness automotive, pipeline and critical structural applications. Among those applications are fracture-critical beams, forging quality bars, ship plate and pressure vessels.

Conclusion

Attaining high strength and toughness for next generation rebar applications requires clean steel practices to control sulphur levels at less than 0.007%, phosphorous at less than 0.030%, as well as to control residual levels and reduce the maximum carbon level to 0.20% C. Today's rebar and long product producers should consider introducing these steps to realize high strength and toughness achieved in many automotive, pipeline and other critical structural applications. This integration of product and process metallurgy can transform the rebar industry, specifically obtaining high quality, high strength Nb-bearing reinforcing bar steels designed to meet the demands for resilient buildings and infrastructure well into the future.

The 7.1 magnitude earthquake that rattled Anchorage, Alaska, in November 2018, underlined the effectiveness of stringent building codes that include minimum rebar standards for seismic-resistant construction. Despite the massive earthquake and aftershocks, there were no fatalities, no widespread injuries, and no buildings that collapsed within the city of Anchorage.

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Tantalum and niobium intellectual property update

This information is taken from the European Patent Office (www.epo.org) and similar institutions. Patents listed here were chosen because of their apparent relevance to tantalum and/or niobium. Some may be more relevant than others. Note that European patent applications that are published with a search report are 'A1', while those without a search report are 'A2'. When a patent is granted, it is published as a B document. Disclaimer: This document is for general information only and no liability whatsoever is accepted. The T.I.C. makes no claim as to the accuracy or completeness of the information herein.

Title Publication #	Applicant(s)	Publication date

TANTALUM

Title / Publication #	Applicant(s)	Publication date
Systems and methods for superconducting quantum refrigeration US2021102838 (A1)	UNIV ROCHESTER [US]; CONSIGLIO NAZ DELLE RICERCHE CNR [IT]	2021-04-08
Method of obtaining complex lithium tantalate of strontium and lanthanum RU2744884 (C1)	FEDERALNOE GOSUDARSTVENNOE BYUDZHETNOE UCHREZHDENIE NAUKI INST KHIMII TVERDOGO TELA URALSKOGO OTDELE [RU]	2021-03-16
Transparent tantalum oxide glass-ceramics and transparent aluminium tantalate glass-ceramics US2021078897 (A1)	CORNING INC [US]	2021-03-18
Etching compositions US2021087467 (A1)	FUJIFILM ELECTRONIC MAT USA INC [US]	2021-03-25
Tantalum powder and preparation method therefor US2021060654 (A1)	NINGXIA ORIENT TANTALUM IND CO LTD [CN]	2021-03-04
Tunnel magnetoresistance (TMR) element having cobalt iron and tantalum layers US2021065949 (A1)	ALLEGRO MICROSYSTEMS LLC [US]	2021-03-04
Method of forming a thin film of tantalum with low resistivity US2021062320 (A1)	X FAB FRANCE [FR]	2021-03-04
Tantala ring resonator and method for fabricating nonlinear photonic devices US2021055627 (A1)	YU SU PENG [US]; PAPP SCOTT B [US]; CARLSON DAVID [US]; SRINIVASAN KARTIK [US]; JUNG HOJOOG [KR]	2021-02-25
Tantalum capacitor KR20210016811 (A)	SAMSUNG ELECTRO MECH [KR]	2021-02-17
High voltage tantalum anode and method of manufacture USRE48439 (E)	GREATBATCH LTD [US]	2021-02-16

NIOBIUM

Title / Publication #	Applicant(s)	Publication date
Free-standing, binder-free metal monoxide/suboxide nanofiber as cathodes or anodes for batteries US2021111390 (A1)	UNIV DREXEL [US]	2021-04-15
Method of synthesizing spinel GaNb4Se8 RU2745973 (C1)	FEDERALNOE GOSUDARSTVENNOE BYUDZHETNOE UCHREZHDENIE NAUKI INST FIZIKI TVERDOGO TELA ROSSIJSKOJ AKADE [RU]	2021-04-05
Powder material and method for manufacturing moulded article US2021094097 (A1)	FUJIMI INC [JP]	2021-04-01
Solution containing lithium, niobium complex and hydrazine, method for producing same, & method for producing… WO2021060095 (A1)	DOWA ELECTRONICS MATERIALS CO [JP]	2021-04-01
Solar cell US2021091323 (A1)	PANASONIC IP MAN CO LTD [JP]	2021-03-25
Fast charging lithium-ion battery US2021083279 (A1)	IND TECH RES INST [TW]	2021-03-18
Method of forming a superconductor interconnect structure AU2021201266 (A1)	NORTHROP GRUMMAN SYSTEMS CORP	2021-03-18
Large-size high-niobium and high-temperature 706 alloy ingot and smelting process thereof WO2021036226 (A1)	GAONA AERO MAT CO LTD [CN]; FUSHUN SPECIAL STEEL SHARES CO LTD [CN]	2021-03-04
Niobium compound and method of forming thin film KR20210017069 (A)	SAMSUNG ELECTRONICS CO LTD [KR]; ADEKA CORP [JP]	2021-02-17
Mesoporous niobium nitride-carbon composite preparation method thereof and potassium ion battery… KR20210024731 (A)	KOREA ADVANCED INST SCI & TECH [KR]	2021-03-08

T.I.C.'s 62nd General Assembly

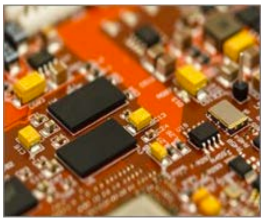
(conference and AGM) will take place in

Geneva, Switzerland,

September 19th - 22nd 2021

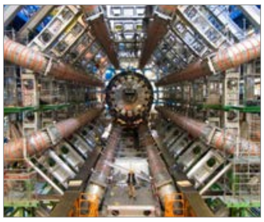
Non-members are welcome to attend this event. The T.I.C. General Assembly attracts industry leaders from around the world. Full details will be made available online at www.tanb.org.

Our 2021 conference will explore issues such as:

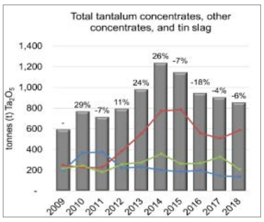


Capacitors

Superalloys



Superconductors



Statistics

And much more

Full details will be made available online at www.tanb.org.

Presentations are given in English with simultaneous translation. All questions about the General Assembly, including about sponsorship opportunities, should be sent to Emma Wickens at info@tanb.org. Full details will be published in future editions of the Bulletin.

The 62nd General Assembly will include the award ceremony for the 2021 Anders Gustaf Ekeberg Tantalum Prize, the annual award for excellence in tantalum research and innovation.

This year our field trip will be to CERN, one of the world's leading centres for scientific research (and a major user of niobium in superconducting magnets!).

Diary of industry events*

- Roskill's Technology Metals 2021 conference (virtual), June 4th 2021
- IAEA's 42nd TRANSSC meeting, June 14th - 17th 2021
- Tarantula (Month 24) (virtual), June 22nd 2021
- MMTA International Minor Metal Conference, Charleston, South Carolina, USA, September 12th - 14th 2021
- **T.I.C.'s 62nd General Assembly and 2021 AGM, September 19th to 22nd 2021**
- RBA & RMI Annual Conferences (venue tbc), w/c October 18th 2021
- CRU Ryan's Notes Ferroalloys, Orlando, Florida, October 24th - 26th 2021
- IAEA's 43rd TRANSSC meeting, (tbc) November 2021
- FORMNEXT, Frankfurt, Germany, November 16th - 19th 2021
- Tarantula (Month 30) (virtual), (tbc) December 2021
- Investing in African Mining Indaba, Cape Town, South Africa, February 7th - 10th 2022

* correct at time of print

Member company updates

Changes in member contact details

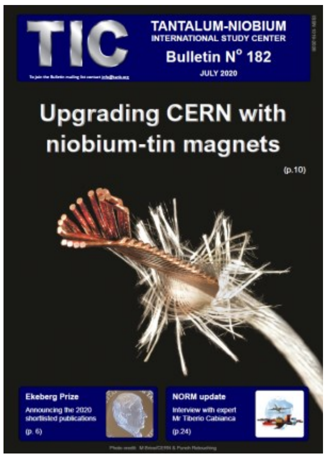
Since the last edition of this newsletter the following changes have been made to delegate contact details:

- **Jiujiang Zhongao Tantalum & Niobium Co. Ltd**: The delegate, Dr Che Jiahe has a new email address, tonyzatanb@qq.com. All other details remain unchanged.
- **Chee Ng Minerals Sdn Bhd** has updated its mailing address as 22½ Mile Stone, Ipoh-Kampar Road, 31900 Kampar, Perak, Malaysia [note: the line "Letter Box No.4" has been deleted]. All other details remain unchanged.
- **Traxys** has appointed Ms Imilia Boussaidi its new delegate. She can be contacted at imilia.boussaidi@traxys.com. All other details remain unchanged.

Join our mailing list to receive the Bulletin by email, free each quarter

Our mission with the Bulletin is to provide the global tantalum and niobium community with news, information and updates on our work. We hope you enjoy reading it! Recipients will also receive messages about the T.I.C. and our General Assemblies.

Email **info@tanb.org** to join our mailing list and keep up to date with the T.I.C. The full archive of Bulletins, including Bulletin Reviews, is available at TaNb.org.



Editor's Notes

London, UK

Dear T.I.C. Members and stakeholders,

As the global pandemic continues to negatively impact the way we live on Earth, this year we have chosen an inspirational photo taken on another planet to be the front cover of our 2021 Bulletin Review. This is not pure escapism, however tempting that might be, but rather it is to celebrate the three spacecraft which have recently arrived at Mars and recognise the essential role which tantalum and niobium played in their success.

The three spacecraft, Mars 2020 (USA), Tianwen-1 (China) and Al-Amal (UAE), all arrived in the orbit of Mars during February and the Bulletin Review cover photo shows a self-portrait taken by the American rover *Perseverance*. From the C-103 niobium alloy nozzles on rockets to the tantalum capacitors used in the instruments, the unique properties of tantalum and niobium make inter-planetary expeditions possible!

The Bulletin Reviews are the special editions we publish annually in Chinese, French, Japanese and Portuguese, and they play a central role in communicating the Association's values and objectives to key markets around the world. While all global organisations need a day-to-day lingua franca, which for the T.I.C. is English, broadcasting in a single language will never achieve the depth of market penetration that can be achieved by repeating the same message in several different tongues. The T.I.C. represents the interplanetary tantalum-niobium community and the Bulletin Reviews embody our world-wide outlook. Perhaps one day we shall publish a 'Mars' edition too...

Please feel free to share them with anyone who shares our interest in tantalum and niobium.

Take care of yourself and those dear to you.

Best wishes,

Roland Chavasse

The Bulletin is published by the Tantalum-Niobium International Study Center (T.I.C.); ISSN 1019-2026. Editor: Roland Chavasse; Production Director: Emma Wickens.
The T.I.C. can be contacted at info@tanb.org; www.tanb.org; +32 2 649 51 58, or at the registered address: Chaussée de Louvain 490, 1380 Lasne, Belgium.

The T.I.C. is an international, non-profit association founded in 1974 under Belgian law that represents around 90 members from over 30 countries involved with all aspects of the tantalum and niobium industry. The T.I.C. is managed by an Executive Committee elected from the membership and representing all segments of the industry. Corporate membership costs EUR 2750 per year and full details of benefits are available at www.TaNb.org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