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SPECIALTY METALS AND THE NATIONAL DEFENSE
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An Important Strategic Problem is Identified.

Over the last 24 months, the Specialty Steel Industry of North America (SSINA) has expanded its membership to include virtually all North American manufacturers of stainless steels and Ni base alloys, including superalloys. Other specialty metals such as titanium and titanium alloys, zirconium, and niobium alloys are also produced by some SSINA member companies. Importantly, the focus of SSINA is specialty metals, not conventional "steel". It is also important to note that the US industry is modern and efficient, and is at the leading edge ... throughout the world ... in both new product development and the implementation of advanced manufacturing technology.

Most recently, SSINA has been pursuing one primary mission – bringing attention in Washington to what we believe is a potentially serious long range strategic problem for the United States. It is our belief that over an extended period of time, **the US could gradually lose its domestic specialty metals manufacturing base if US manufacturers of specialty metals ... like so many other manufacturers ... move production offshore in search of what they perceive to be better business opportunities and higher profits**. As importantly, were this to happen, not only would the US lose its manufacturing base, but .... **it would also lose its leading edge position in specialty metals technology** ... **along with its ability to develop new technology**. This is because if the manufacturing base moves, research and development soon would be shifted abroad as well in order to take advantage of lower costs and ties to the manufacturing process. In this industry... "**our factories are our laboratories.**" This link between manufacturing and technology development is not well understood or appreciated by most people. It certainly seems not to be appreciated by many members of the US government or by so-called free trade economists who permeate Washington and other policy making centers around the world. It is naïve, at best to think that a leading edge position in specialty metals technology can be maintained in the US in the absence of a healthy and vibrant domestic manufacturing activity.

Why is this important to US national interests? Were this to happen and specialty metals manufacturing and technology development to leave the country... the impact of such a transition on US defense systems and defense capabilities would be significant and decidedly negative. In short, **the specialty metals industry is critical to national defense.** Maintaining a healthy domestic specialty metals industry and its ability to

create new, leading edge technology is vital to the security interests of the US. Advanced weapons systems can neither be built nor operated without these materials. The next section of this report is intended to justify this claim.

Specialty Metals are Critical to National Defense

Over the past 15 months, SSINA, working with the Defense Department, has identified many critical defense applications that rely on specialty metals. This has been done in order to provide convincing evidence that these materials are, in fact, critical to national defense.

Specialty metals are vitally important to virtually every US military platform. Simply put, weapons systems can neither be built nor operated without these materials. Whether it is missiles, jet aircraft, submarines, helicopters, Humvees® or munitions, American-made specialty metals are crucial components of US military strength. Attached as Exhibit 1 is a sampling of current leading edge military applications of specialty metals as identified by surveying SSINA member companies. Exhibit 1A contains more detailed company-specific descriptions of selected applications from Exhibit 1. Both Exhibit 1 and 1A represent only a small subset of the many defense related applications of specialty metals. These exhibits are not intended to be inclusive, rather, they are intended to be illustrative of the critical role that these materials play. Technical and business confidentiality issues prevent a more complete disclosure of these and other important applications.

Further illustration of the critical importance of specialty metals to national defense is provided by DOD studies, themselves. Beginning in 2004, the Department of Defense ("DOD") has conducted Defense Industrial Base Capabilities Studies ("DIBCS") to determine the amount of equipment and services needed to meet national defense requirements and to focus on critical technologies that are important to 21st century warfare. DOD has published five DIBCS reports, which include: (1) DIBCS: Battlespace Awareness (January 2004); (2) DIBCS: Command and Control (June 2004); (3) DIBCS: Force Application (October 2004); (4) DIBCS: Protection (December 2004); and (5) DIBCS: Focused Logistics (June 2005). The DIBCS reports all contain discussions of selected defense applications currently used for US military platforms, as well as applications that will be utilized in future platforms. During an initial meeting with DOD, we were asked to review this list of applications and help DOD understand the role that specialty metals play in these critical applications. We have done so, and the results are shown in Exhibit 2. This summary clearly shows that specialty metals are essential to many key defense applications identified by DOD in the DIBCS series. It is also notable that there are many defense applications for specialty metals that are not referenced in the DIBCS studies.

Not only are these metals an integral part of many diversified military applications, it is apparent from these examples that specialty metal products are not commodities. Rather, they are very high tech in nature and are in a continuing state of

technology development. They are not "off the shelf items". Often it is the superior performance of these materials under severe operating conditions that enable defense systems to function at high levels of performance and to do so reliably. Equipment maintenance is frequently a very important tactical issue. **As these examples illustrate, specialty metals play a major role in both the design and reliability of defense systems, and both of these areas are in a continuing state of technology development**. Because of the critical nature and advanced technology characteristic of these materials, and because so many of them have been invented and developed by the domestic specialty metals industry, many of these materials are proprietary and either "sole-sourced" to a single US company or supplied only by the domestic industry.

As additional confirmation of the critical importance of specialty metals to national defense, over 30 years ago, Congress enacted the Specialty Metals Amendment to the Berry Amendment in order to recognize the importance of the industry to national defense and help insure its long term survival. The ongoing importance of this statue to national defense has been confirmed virtually every year since during debate in Congress. Most recently, the DOD published notice in the Federal Register of their intent to strictly follow the provisions of this law.

Can We Afford to Allow our Industry to Atrophy over Time and Leave the Country?

... and if the Answer is No ... What Should We do About It?

It is relatively easy for people familiar with the specialty metals industry to agree with the assertion that US defense capability could be significantly compromised if the specialty metals industry were to move offshore in pursuit of increased profitability. Hopefully the above examples provide convincing proof of this assertion to those less familiar with the industry. And so the answer to the first part of this question is clearly ... No ..., we cannot afford to allow this industry to leave the country. **But what should we do about it? What can we do about it**? Encouragingly, more and more often we are being asked this specific question as SSINA representatives discuss this issue with various individuals in Washington.

Our response to this question is simple and direct: The US lacks a coherent strategy related to all manufacturing ...but more importantly in this context ...it lacks one related to specialty metals ... and the US government needs to move quickly to create one. What are the factors to consider in creating such a strategy? The answer to this follow-up question boils down to addressing how companies, or CEO's of companies, make investment decisions. Why do they choose to invest overseas instead of the US? Can anything meaningful be done to favor investment here that is consistent with our beliefs in the importance of the free enterprise system and the principles of free and fair trade?

In essence, companies make investment decisions based on the expected rate of return on their investments relative to their cost of capital. It is critically important to

recognize that these factors are considerably different in different parts of the world. There is not a level playing field and each year the field seems to tilt further in favor of investment outside the US. Most importantly, other countries are manipulating the field to their advantage while our country is sitting on the sidelines doing very little to influence investment decisions. It is important to remember that the very nature of the US free enterprise system encourages individual companies to pursue the financial interests of their shareholders without regard to any overarching national objectives. Given that fact, **the only meaningful way to influence this situation is for the US government to make sure the playing field is at least level with regard to factors influencing investment. And that is not being done.**

Incentives to invest overseas continue to increase. The list is long and includes favorable tax treatment, lower operating costs .. some legitimate ... but some heavily influenced by foreign government intervention, outright subsidies including currency manipulation, and inconsistent application of the principles of free and fair trade that end up favoring foreign investment. Access to foreign markets is an additional reason, but the ability to do so is often manipulated by foreign governments, and is becoming increasingly linked to a rapid transfer of "best available" technology from the US to foreign countries. This is particularly true in China's case. In other words, technology transfer is often a quid pro quo for investment in China. Numerous examples of this across the spectrum of the manufacturing sector appear almost daily in the business press. They are rarely characterized by the media as problems for US national security. Instead, they are viewed as opportunities for US corporations and their shareholders.

China's approach is a systematic, highly coordinated, strategic initiative which left unchallenged will eventually result in the transfer of significant technology and manufacturing capability to China. China's infrastructure in this area is being completely rebuilt with state of the art equipment, which will result in an increase in its global position in the specialty metals sector and downstream manufacturing industries. However, to date, critical manufacturing process technology that would be necessary for most important defense applications has not been transferred to the Chinese, to the best of our knowledge. On the other hand, in the commodity stainless steel arena, a combination of foreign investment, significant transfer of western process technology, and government subsidization have resulted in a dramatic growth in capability. In a period of less than three years, China has become a major exporter of stainless steel flat-rolled products – a core commodity product of US producers. China is now the number two offshore source of stainless flat-rolled products in the US market, having increased its exports to the US by over 500% in the past year. In stainless long products (bar, rod, wire), which are critical to numerous aerospace and defense programs, Chinese imports have increased by 83%.

In this context, it is important to understand that there is not a sharp line that separates critical defense related technologies from important processing technology related to the manufacture of these same specialty metals for non-defense applications. It has taken our industry decades to develop the basic processes required to make high quality specialty metals for demanding non-defense related applications, e.g. commercial

aerospace. Therefore, there are numerous, basic technologies that while being US export-compliant, are nonetheless critical to development of leading edge defense applications. Transferring basic technologies to China would greatly facilitate Chinese mastery of more leading edge technologies.

At the same time, **disincentives to invest in the US continue to mount.** The list is also long and includes exponentially rising costs of energy, healthcare and post-retirement benefits, exorbitant regulatory and legal costs, high taxes, along with increasing concerns regarding enforcement of US trade laws and the ability of the US to establish fair trading practices with its global trading partners, as required by all WTO principles and agreements.

What are the solutions to this problem?

At first blush, it almost seems that there is no solution and that the eventual demise of the US specialty metals manufacturing base ....and its ability to develop new specialty metals technology .... is inevitable. It is only a matter of time. But this is **not** how SSINA feels. We believe that meaningful things **can** be done to address this potential problem.

Before discussing our suggestions, it is important to understand one other important feature of this industry. Leading edge defense applications represent less than 10% of overall sales of these specialty metals companies. However, defense-related products are processed over the same equipment and developed by the same engineers that support all the other businesses of these companies. Because of this, SSINA member companies are not typical defense contractors. They do not derive most of their sales and profits from their defense business. Thus for this industry to attract investment, survive and prosper here in the US, it is the overall financial health of these companies that is of utmost importance, not the profitability of their defense business per se. So in looking for solutions to this problem, we must look at very fundamental issues related to the core businesses of these companies that tilt the table in favor of making investments in the US.

What Should be Done to Level the Playing Field As to How Investment Decisions are Made?

In short, we need to do two things: First, the US government ... working with industry ... needs to become proactive. It needs to create an industrial policy that encourages investment here ... and secondly ... we need to help ourselves by accelerating efforts to reduce costs, automate and streamline manufacturing processes here in the US.

In the remainder of this report, we concentrate on the first issue ... that is the US government's role ... the issue of creating and enforcing an industrial policy that levels the playing field relative to making ongoing investments here in specialty metals manufacturing and technology development.

There is much confusion on this subject in Washington. Industrial policy is not a popular subject. It is often associated with protectionism, isolationism, and with the government picking winners and losers. All of these characterizations are at odds with the free enterprise system. For that reason they are unacceptable concepts and can be summarily rejected. Unfortunately, emotions run so high on this issue that open-minded discussions of more creative industrial policy concepts seldom if ever seem to occur.

SSINA believes that an effective industrial policy consistent with the principles of free enterprise **can** be created. It is our belief that **the US should develop an industrial policy that levels the "investment" playing field making the following simple assumptions**:

1. US multinational companies will continue to invest here if the "investment" playing field is relatively level because investing in the US will be a viable, reasonably low cost option with considerably less business risk.

2. It is not necessary or even desirable to stop investment overseas by multinational companies. It is only necessary to create an environment that encourages significant, ongoing investment here.

3. If investment continues to occur in the US at a reasonable rate, the US will **never** effectively lose its manufacturing base and the competitive advantage that it currently enjoys in specialty metals.

Note that **none of these concepts is protectionist or isolationist in nature**. In our opinion, it would be wrong to attempt to build a wall around the US. This is not necessary or desirable, in our opinion. Many SSINA member companies are multinational companies. We are not suggesting that this needs to change.

At the risk of oversimplifying the situation, SSINA believes that **three primary issues are involved in leveling the "investment" playing field: trade, costs and taxes.** To us, it is convenient and helpful to view these issues as three legs of a stool that tilt the table one way or another with regard to how investment decisions are made by multinational companies. We intend to develop detailed position papers around each of these issues in the coming months, but at this point we would like to comment on each in a little more detail.

Right Now Trade is Not Fair....

Many countries in the world are not playing by the rules of fair trade, including those established by the WTO. Numerous examples exist including government subsidies, currency manipulation and dumping. The US, although encouraging the reduction of tariffs in pursuit of free trade, is woefully lacking when it comes to demanding the enforcement of fair trading principles by our trading partners as stipulated in WTO agreements that they have signed. Our government's ineffective strategy and

tactics in this area actually tilt the table in favor of foreign investment rather than encouraging investment in the US.

In this regard, it is instructive to ask: What constitutes a government subsidy in this day and age? For example, if a foreign government such as China is:

- manipulating the supply and demand balance of a given industry in their home country by requiring major capital investments to be approved by the government prior to implementation, or
- orchestrating the consolidation of industries, or
- regulating the equity ownership of individual companies, or
- restricting the export of critical raw materials while, at the same time,
- attempting to use government funds to purchase equity interests in companies owning and producing critical raw materials outside of their own country, with the intent of making these raw materials available to Chinese producers, which compete against US manufacturers of specialty metals and which must procure these same raw materials in an open market --

... are these subsidies? Maybe not by some conventional definitions, but they should be considered as such. The impact of these actions on profitability can be significant and tilt the playing field against investment in US manufacturing. DOD procurement policies may actually accelerate and encourage this process.

Current foreign direct investment policies of western companies in other industries already are facilitating the transfer of technology and manufacturing to China. If and when this happens in specialty metals, it will result in the gradual loss of US defense capability, and we will have facilitated our own demise.

Apart from trade-related issues, China's growth, per se, clearly has fueled the unparalleled run-up in prices of all raw materials, resulting in significant increases in the price of many specialty metals that contain these raw materials.

Cost Structures are Not Fair ...

Many cost elements, *apart from labor*, are much higher in the US than in other locations around the world. This does not need to be the case. For example, cost factors related to energy, environmental regulations, other regulatory requirements, and post-retirement benefits are disproportionately high for manufacturers of specialty metals in the US and do not need to be. Even in the case of labor costs, the pursuit of job rule flexibility and automation by individual companies in our industry ...and not by government policy ... has significantly reduced any cost advantage attributed to foreign investment. An effective US industrial policy in this area would endeavor to level the "cost" playing field in areas other than direct labor. For example, it might: include

initiatives to significantly lower energy costs for manufacturers, demand that the environmental control systems in foreign countries increase to levels comparable to those used by US manufacturers of specialty metals, reduce non-value added regulatory costs here, and decrease the burden of post-retirement benefit costs to US manufacturers. And last but not least, it might also include initiatives to improve the effectiveness of our educational systems and expand ways for the US government to partner with industry in helping defray the costs and risks associated with new technology development.

and ...the US Tax System Discourages Investment in This Country

For example, corporate income taxes are much higher in the US compared to other countries, particularly with regard to their effect on investment decisions in manufacturing. In addition, many other economies utilize VAT systems to encourage exports ... something that the US does not do, but should consider.

Conclusions

Is there a crisis today in the specialty metals industry? No, but there could be if we don't act. Today there are fewer companies producing specialty metals in North America than at any time in the last 50 years. Overall, our industry is marginally healthy, but the handwriting is on the wall. Now is the time to act. If we wait until the domestic industry is gone, it will be very difficult to reconstruct it in an acceptable timeframe.

Reconstructing the industry, were that to become necessary, is not a matter of equipment. It is a matter of people – highly trained and experienced people at all levels – from the manufacturing floor to the R&D center. The unique nature of specialty materials and their processing is not taught in universities. It must be learned on the job. Once these well-paid, highly-skilled jobs are lost, they cannot be replaced easily or quickly. Symptomatic of this problem, the US currently graduates about 70,000 engineers per year. The number in China is 5 times higher. A few decades ago, the US graduated 3 times as many metallurgical engineers as it does today.

So far, the US political system has not recognized the potential loss of specialty metals manufacturing as a significant problem, and therefore has not put in place well thought-out solutions. It seems content to let the "free trade" free enterprise system run its course, while the US lives by the rules of free enterprise and others do not. But if the US does not act soon, it may be too late.

The US should not lose jobs and manufacturing ability, and weaken our industrial and defense capability for the wrong reasons. It is a question of balance, as with most things in life. Today, the scales tip heavily in favor of moving manufacturing offshore. It's tough being a manufacturer in the US today and it's getting tougher every day. This trend must be reversed, particularly in the case of specialty metals.

Most importantly, there is a solution. SSINA supports the development of an industrial policy that levels the playing field for investment. **US manufacturers *do* need**

relief from unfair competition and no one should be put on the defensive for saying so. However, we *do not* need protection if the playing field is level. We believe that if this is done ... and we believe it can be ... US manufacturers of specialty metals can continue to successfully compete with anyone in the world and our future will be secure.

Recommended Actions

SSINA recommends that dramatic, comprehensive and swift actions be taken as follows:

- First, the US needs to create an industrial policy that encourages investment in US manufacturing, particularly as it relates to specialty metals. Suggestions as to how this can be done are included in this report.

- Second, Congress and the Administration should closely monitor the behavior of strategic trading partners like China in order to make sure that the US specialty metals technology and industrial base is not systematically and significantly weakened by overt and coordinated foreign trading and investment activities inconsistent with the principles of free enterprise, fair trade and WTO rules.

PUBLIC VERSION
December 2005

EXHIBIT 1

SUMMARY OF SSINA DEFENSE-RELATED BUSINESS

Type	Application	Specialty Metals Classification
Missiles	Guidance	Magnetic/Electronic
	Motors	Magnetic/Electronic
	Locking Pins	Stainless Steel
	Engine	High Temperature Alloy
	Control Fins	Magnetic/Electronic
	Fuel Cell	Stainless Steel
	Solenoid Switch	Stainless Steel
	Wave Tube Assembly	Magnetic/Electronic
	Air to Air Missile	High Strength Alloy
	Thrust Nozzle	Titanium Alloy
	Gas Bottle	Stainless Steel
	Cut Core Transformers	Magnetic/Electronic
	Structurals	Stainless Steel
	Steering Vanes	High Strength Tungsten
	Missile Casings	High Strength Alloy Steel
	Gas Generator Reducer	Niobium Alloy
	Missile Components	Alloy Steel
	Aircraft Missile Bearings	Stainless Steel
Aircraft	Magnetic Shield	Magnetic/Electronic
	Guidance	Magnetic/Electronic
	Generators	Magnetic/Electronic

Type	Application	Specialty Metals Classification
	Structurals	Stainless Steel
	Blades	High Temperature Alloy
	Rings	High Temperature Alloy
	Shafts	High Strength Alloy Steel
	Disks	High Temperature Alloy
	Engine Blade	Magnetic/Electronic
	Engine Mounts	High Strength Alloy Steel
	Wing Controls/Navigation	High Temperature Alloy
	Pylon Assembly	Stainless Steel
	Gear Assembly	High Strength Alloy Steel
	Jet Engine Case	High Temperature Alloy
	Engine Drive Shaft	High Temperature Alloy
	Landing Gear	High Strength Alloy Steel
	Lift Fan Gear	Alloy Steel
	Engine Components and Fasteners	High Temperature Alloy Steel
	Engine Manifold	Stainless Steel
	Engine Power Unit	Stainless Steel
	Generator Laminations	Magnetic/Electronic
	APU's, Generators	Magnetic/Electronic
	Bolts	Alloy Steel
	Blind Rivets	Stainless Steel
	Rivets	Corrosion Resistant Alloy
	Rivets - Aircraft Brake Shoes	Stainless Steel
	Airframe/Structural/Gears	Alloy Steel
	Landing Gear	Stainless Steel
	Engine and Transmission Bearings	High Temperature Bearing Steel
	Tail Hooks	High Strength Alloy Steel

Type	Application	Specialty Metals Classification
	Flap Actuators	High Strength Alloy Steel
	Rocket Engine Castings	Alloy Steel
	Gas Turbine Engines	Nickel/Cobalt High Strength Alloy
	High Pressure Hydraulics	Titanium Alloy Tubing
	Jet Engine Tail Feathers	Niobium Alloy
	Rocket Nozzle Thrust Skirt Extension	Niobium Alloy
	Vectoring Nozzle	Vanadium Alloy
	Hot Gas System	Tantalum Alloy
	Single Crystal Turbine Blades	High Temperature Alloy
	Hypersonic Scramjet Engine	Niobium Alloy
	Gun Barrels	Alloy Steel
	Catapult Rails	Stainless Steel
	Honeycomb Applications	Titanium Alloy
	Aircraft Fasteners	High Temperature Nickel Alloy
	Aircraft Structurals	High Strength Alloy Steel
	Aircraft Components	Alloy Steel
Helicopters	Main Gear	Alloy Steel
	Engines	High Temperature Alloy
	Rotor Housing	Stainless Steel
	Rotor Gear	Alloy Steel
	Main Rotor	Alloy Steel
	Engine Compressor	High Temperature Alloy
	Blade Stabilizer	Stainless Steel
	Transmission Gears	Chromium-Nickel-Steel
	Rotor Shafts	Low Alloy Nickel Steel
	Rotor Flanges	Low Alloy Nickel Steel

Type	Application	Specialty Metals Classification
	Rotor Flanges	Stainless Steel
	Engine and Transmission Bearings	High Temperature Bearing Steel
M-1 Tank	Engine Cover	Stainless Steel
	Engine Blade	High Temperature Alloy
	Torsion Bars	High Strength Alloy Steel
Bradley	Gun Turret	High Strength Alloy Steel
	Torsion Bars	High Strength Alloy Steel
Humvee	Door struts	Stainless Steel
	Armor	Titanium Alloy
Stryker	Light Weight Road Wheels	Titanium Alloy
Submarines	Piping Systems	Stainless & Hi-Temp.
	Launcher Tube	Stainless Steel
	Propulsion Shaft Magnetic	Magnetic/Electronic
	Propulsion	Nickel/ Titanium Alloy
	Power Generation	Nickel/ Titanium Alloy
	Weapons support	Nickel/ Titanium Alloy
	Reactor Core	Magnetic/Electronic
	Fasteners	High Strength Superalloy
Munitions	Fuse Devices	Stainless Steel
	Fuses	High Strength Alloy Steel
	Bunker Buster Bombs	High Strength Alloy Steel

Type	Application	Specialty Metals Classification
Artillery	Cannon Barrels	High Strength Alloy Steel
Space Shuttle	Engine Ring	High Temperature Alloy
	Resistor	Magnetic/Electronic
	Booster Rocket Skin	High Strength Alloy Steel
Marine/Navy	Rivets	Corrosion Resistant Alloy
	Nuclear Systems	Stainless Steel, Zirconium Alloy
	Nuclear Fasteners	Alloy Steel
	Turbines	Stainless Steel
	Shipboard Water Filtration	Titanium Alloy
	Torpedo Launch Systems	Titanium Alloy
	Shafts	Stainless Steel
Other	Bolts	Alloy Steel
	Nuclear Weapons Components	Magnetic/Electronic
	Reactor Core	Magnetic/Electronic
	Radar Aegis System	Magnetic/Electronic
	Night Goggles Glass to Metal Seal	Magnetic/Electronic
	Missile Castings	High Strength Alloy Steel
	Honeycomb Applications	Titanium Alloy

PUBLIC VERSION
December 2005

EXHIBIT 1A

Products below are manufactured by one or more SSINA member companies, often on an exclusive basis. It is obvious from the comments provided that these materials are critical to the functioning of the military systems indicated. It is also apparent from these examples that considerable investment has been required, and continues to be required, to develop, manufacture and improve the properties of these specialty materials and reduce their manufacturing costs.

Aerospace

The Apache attack helicopter is a benchmark of durability and survivability in the harshest environmental and battle conditions. A large part of that capability is due to survivability of the main and tail rotors. The primary structural members (spars) of these rotors are produced from a high tech specialty metal made by an SSINA member company.

The Joint Strike Fighter F-35 aircraft is planned to replace the aging fleet of A-10, F-16, F-18, and AV-8Bs beginning in 2008. Pratt & Whitney is producing the F135 engine that will power the F-35. The F-135 engine will run at elevated temperatures and only the highest technology nickel-based alloys can be used. P&W chose to work with an SSINA member company because of their superior technology for melting and fabrication of nickel-based alloys enabling design of the F-135 turbine engine and the Joint Strike Fighter.

The Joint Strike Fighter F-35 is expected to be in production for more than 30 years. Each plane will utilize approximately 2,000 pounds of an SSINA member company's material, including a special proprietary stainless alloy. This alloy was developed to meet the demanding requirements of critical components used in the manufacture of military aircraft and to insure that components can work in the most difficult environments – all the time. Gears and bearings made from this alloy will fly on the naval version. The essentially maintenance-free stainless parts can withstand high temperatures and salty sea water and will also be able to rotate in the engine nozzle 90°- a neat trick that allows a plane to land vertically, coming down like an elevator. The functionality of the Joint Strike Fighter would not be possible without this proprietary alloy.

The US Navy F/A-18E/F fighter jet utilizes another patented alloy in several vital components that was developed and made by an SSINA member company. If landing gear fails, it is most often because of stress- corrosion cracking or insufficient toughness. The landing gear needed a tougher alloy with improved resistance to stress corrosion cracking for landings on decks. To prevent such failures, a super strong alloy was developed. Because of these characteristics, it was designed into the nose and main landing gear. Other naval aircraft applications include the shanks for arrester hooks, fasteners, and various structural components. In 1992, this alloy was named one of the top material advances of the decade by the National Association for Science, Technology

and Society. An enhanced version can also be found in numerous naval aircraft applications.

The F119 and F135 turbine engines power the F-22 Raptor and F-35 Joint Strike Fighter aircraft, the air superiority aircraft for the future. An SSINA member company developed and qualified larger diameter titanium forging billet practices improving the supply of these critical products.

Materials used for airframes on military aircraft require toughness and strength, while managing life cycle costs and addressing environmental concerns. To meet this design challenge, an SSINA member company developed a new stainless steel. This stainless steel has an unparalleled combination of high strength, fracture toughness and resistance to stress corrosion cracking. This alloy has longer service life resulting in reduced maintenance and aircraft operating costs. By using this stainless alloy, the need to surface-treat has been eliminated.

Inside the hottest part of jet engines used in numerous military aircrafts, a metal turbine blade must be able to operate 1500° Celsius (2700° Fahrenheit). A normal metal would melt at 1500° Celsius. Besides the design adjustments made by the engine manufacturers, an SSINA member company developed several nickel-based alloys for certain engine and airplane parts. One of these superalloys has a tightly controlled grain size and chemical composition resulting in optimum forged component processing and alloy performance. This alloy is used for critical rotating metal turbine components in military aircraft, which require longer-life parts in the highest quality expectations.

Critical to performance of gas turbine jet engines used in military aircraft is the tight control of air flow in the high-pressure compressor section where temperatures can exceed 650° Celsius (1200° Fahrenheit). Air leaking past compressor blades in either the forward or backward direction can adversely affect fuel consumption and aerodynamics stability. An SSINA member company developed a controlled-expansion alloy in order to minimize clearance throughout the range of temperatures encountered in all flight conditions resulting in optimized engine thrust, efficiency fuel economy, flying range in part life- all critical to military applications.

An SSINA member company sells a proprietary precipitation hardening alloy to honeycomb manufacturers for various applications in fighter jets. Most of this is for structural areas that require high strength to weight ratios.

Other specialty metals products from an SSINA member company are used in the following defense applications: fasteners, clamps, seal rings, and springs. Those products are also used in commercial jets.

An SSINA member company supplies a high-strength, low-alloy steel used for the leading edge on military helicopter blades. This product is a protective shield,

specifically important during landing and takeoffs in sandy conditions. This product is vital in Middle East operations.

An SSINA member company supplies High Strength Low Alloy steel in the form of remelted bloom bar with special tolerances. The remelted steel is used for the Lockheed Martin C-130 Flap Tracks, which is a three-year program.

Hypersonic (> Mach 3) space and missile applications will require skin materials that can handle temperatures in excess of 1200°F. Existing skin materials used on military aircraft and missiles cannot withstand the extreme temperatures experienced by hypersonic vehicles. An SSINA member company is working with the Air Force Research Laboratory to produce temperature resistant sheet from a new proprietary alloy.

The US Air Force is evaluating lower-cost, temperature resistant materials for existing turbine engines. A new proprietary alloy was developed and patented by an SSINA member company for use in applications subject to 1300°F temperatures. This alloy was recently selected as the best alternative to replace a higher cost alloy for low-pressure turbine case applications in legacy and future military engines.

F-100 and F-135 (JSF) jet engine "tail-feathers" are made from a unique specialty metal alloy sheet material supplied by an SSINA member company. These metal strips shape and form the afterburner plume for these military engines. This is one of approximately 200 refractory metal alloys developed for high temperature applications. These alloys require significant, novel, high tech manufacturing capability.

Missiles and Rockets

The second stage of Delta II rocket nozzle thrust skirt extension for the P&W RL-10 engine is made from a proprietary alloy sheet supplied by an SSINA member company. This project requires the ability to successfully cold roll thin sheets of this alloy which is relatively soft at room temperature, and very easy to damage during rolling.

Land Based Vehicles

Light weight road wheels for the Stryker vehicle are made from a titanium alloy by an SSINA member company. Wheels are cast using a unique process and then machined, painted, and rubber coated.

An SSINA member company produces high strength low alloy steel in the form of remelted billet. The billet is used for the Bradley Fighting Vehicle Hydraulic Motor Race, which is an expedited multi-year program.

Naval Applications

SSINA member companies are key suppliers of materials that meet the Navy's advanced technical requirements. Specialty materials such as nickel alloys, specialty steel, and titanium alloys are continually evolving to meet enhanced material specifications used in propulsion, power generation, support structures, hardware, desalination, and weapons support. Technical support and alloy development spanning more than a quarter-century have focused on meeting ever-increasing life expectancy for propulsion units and support systems, helping to increase service life from 20-years to an estimated 40-years.

Armor and Munitions

An SSINA member company currently supplies "dual hard" specialty steel for the critical door struts of the US Army Humvee.

Fuel Cells

This developing technology is intended to supply electric power for numerous military applications from the individual soldier's electronic and communication system needs to ground attack equipment and aerospace applications. An SSINA member company is deeply engaged with many of the US producers of fuel cell systems. These manufacturers are relying on our industry to develop and supply engineered materials to meet these demanding requirements.

Other

SSINA member companies are principal suppliers of ingot and billet to the forging and extrusion industry, which manufacture critical products for use in many different DOD applications, some of which are described above. These starting materials enable forging and extrusion facilities to meet demanding specification requirements such as "Sub Safe Level 1" and "Noform Specification Materials." Applications include: helicopter shafts, missiles fins, ballast blow valves, high pressure valve blocks, torpedo tubes, nuclear cooling systems, aircraft carrier launch bar and space shuttle connecting rings. The forgings can weigh as little as three pounds or as much as 50,000 pounds.

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EXHIBIT 2