JMA ENGINEERING

ATLAS SPECIALTY METALS

WEA Conference 2007

Stainless Steel Grades and Applications in Wineries

JMA & Atlas Specialty Metals

WINERY ENGINEERING ASSOCIATION - LIMITED -

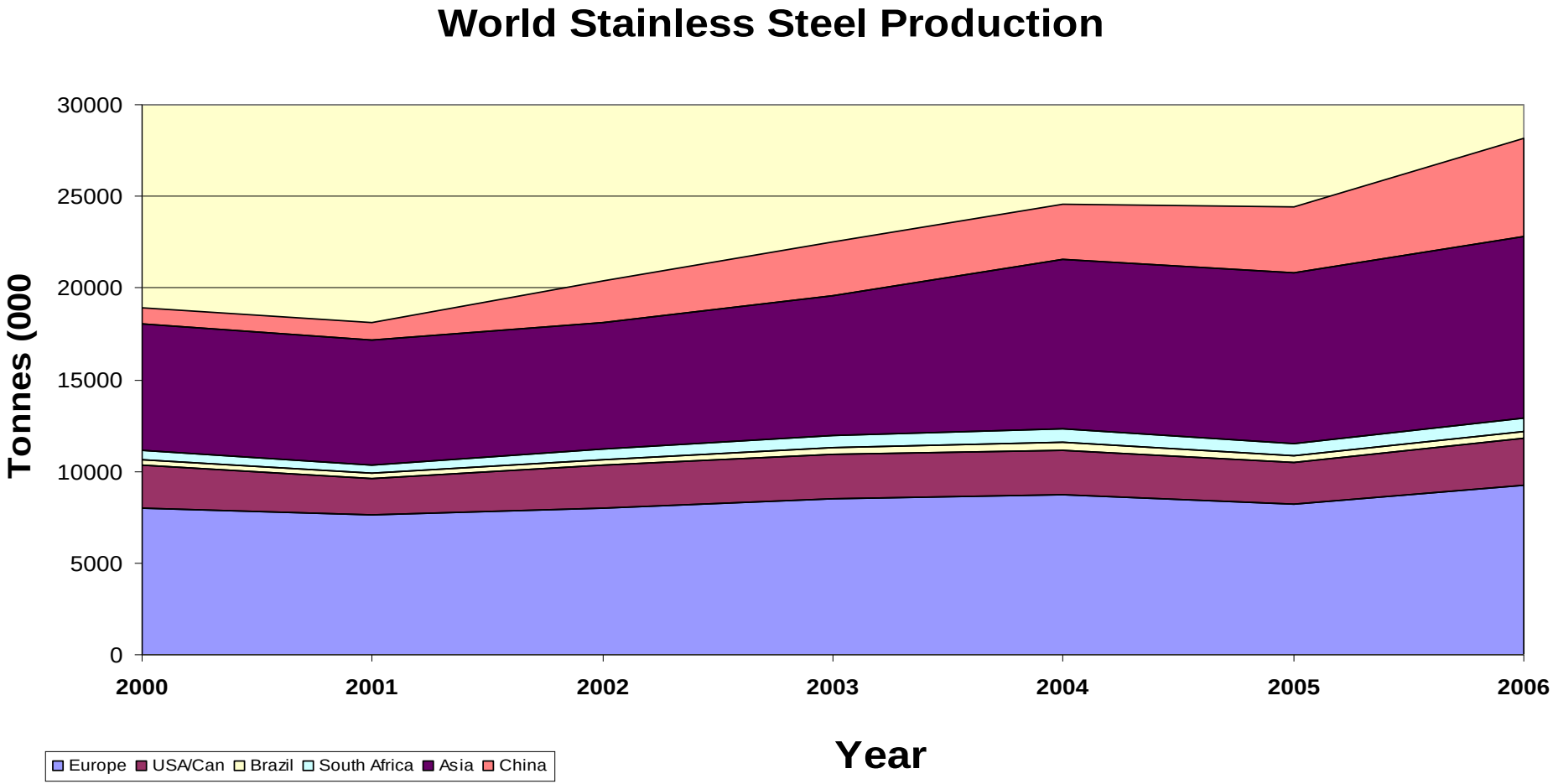
Issues to be Addressed

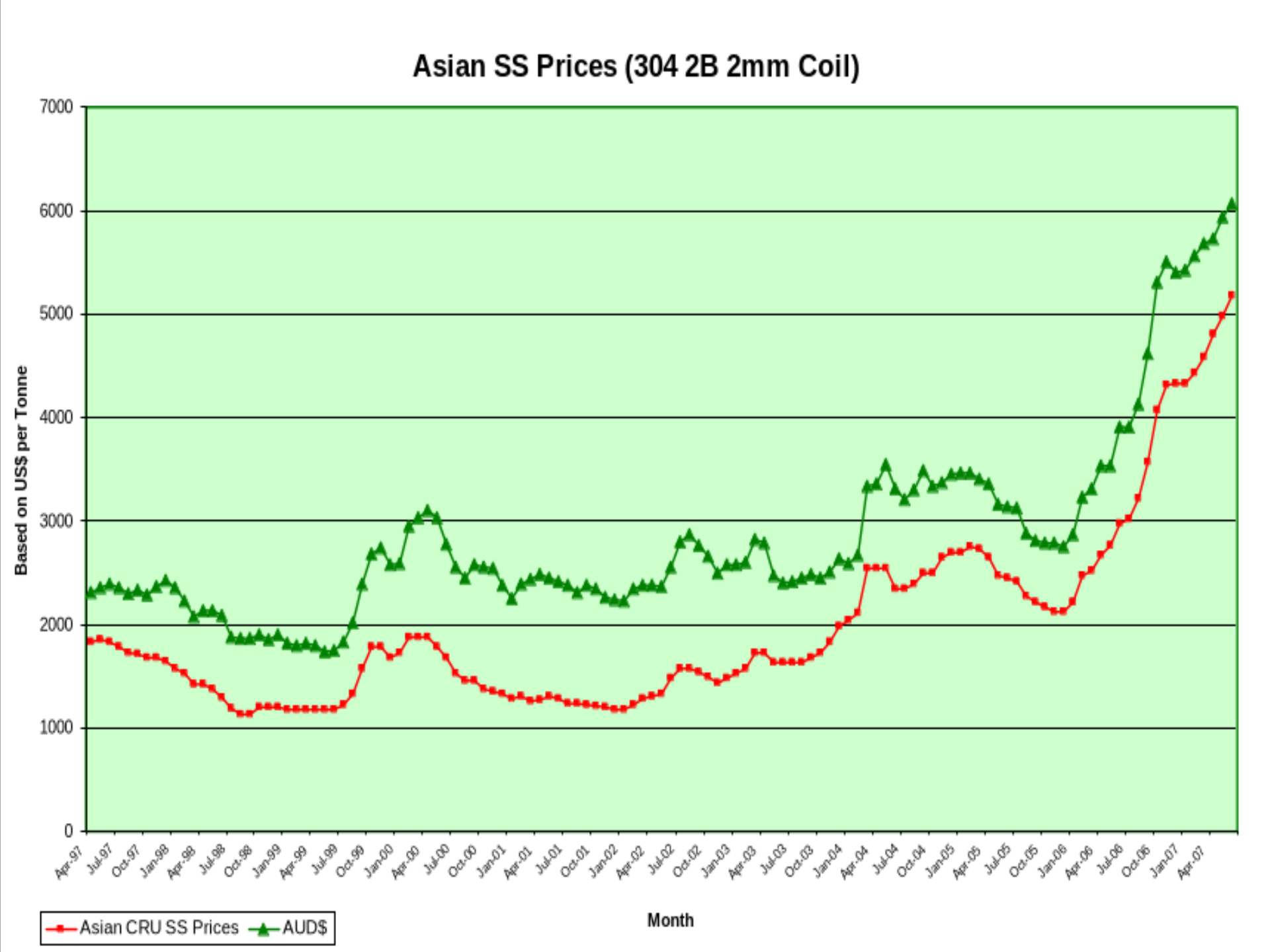
- Why has the price of austenitic stainless steel skyrocketed?
- Where from, to where??
- What are the stainless steel grade alternatives?
- How would you go about selecting an alternative grade?

Why have austenitic stainless steel prices increased?

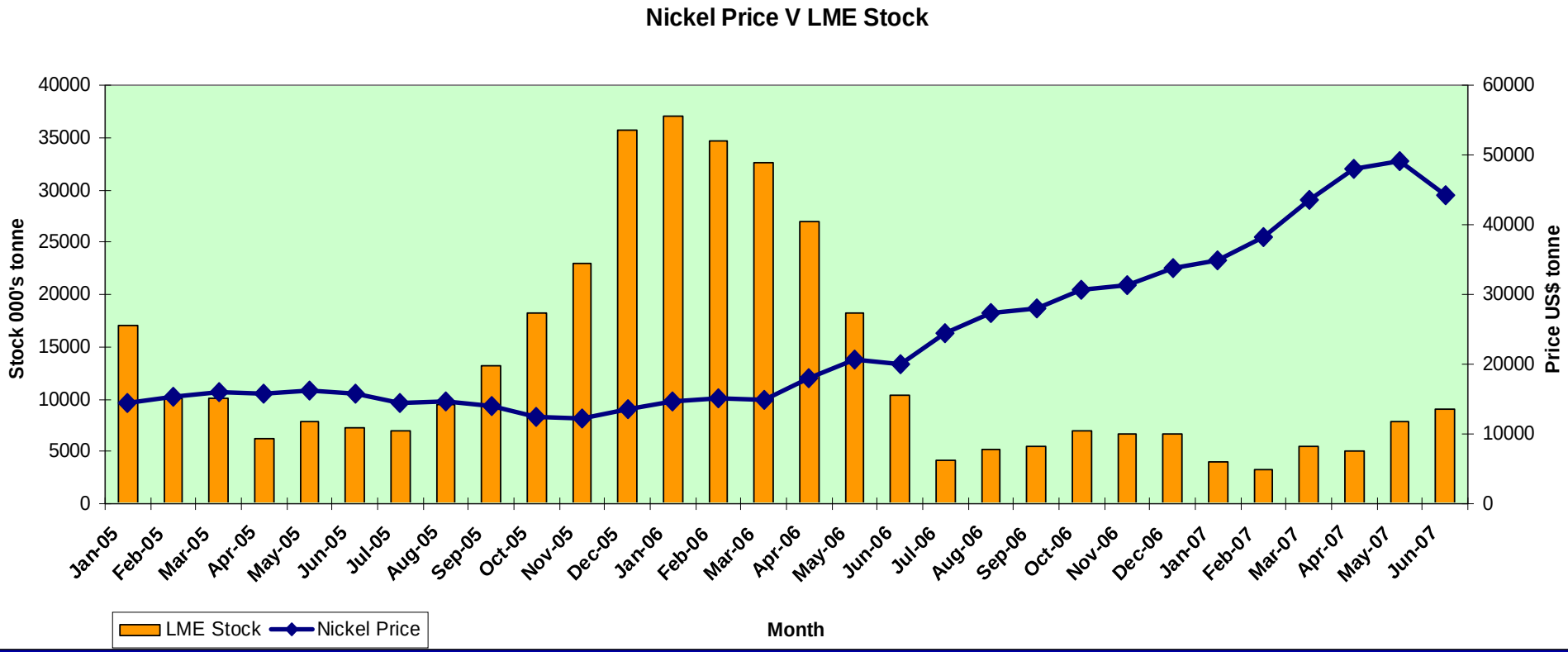
- Stainless steel end use demand – China?
- Commodity demand V supply
  - Nickel
  - Chromium
  - Molybdenum

Demand

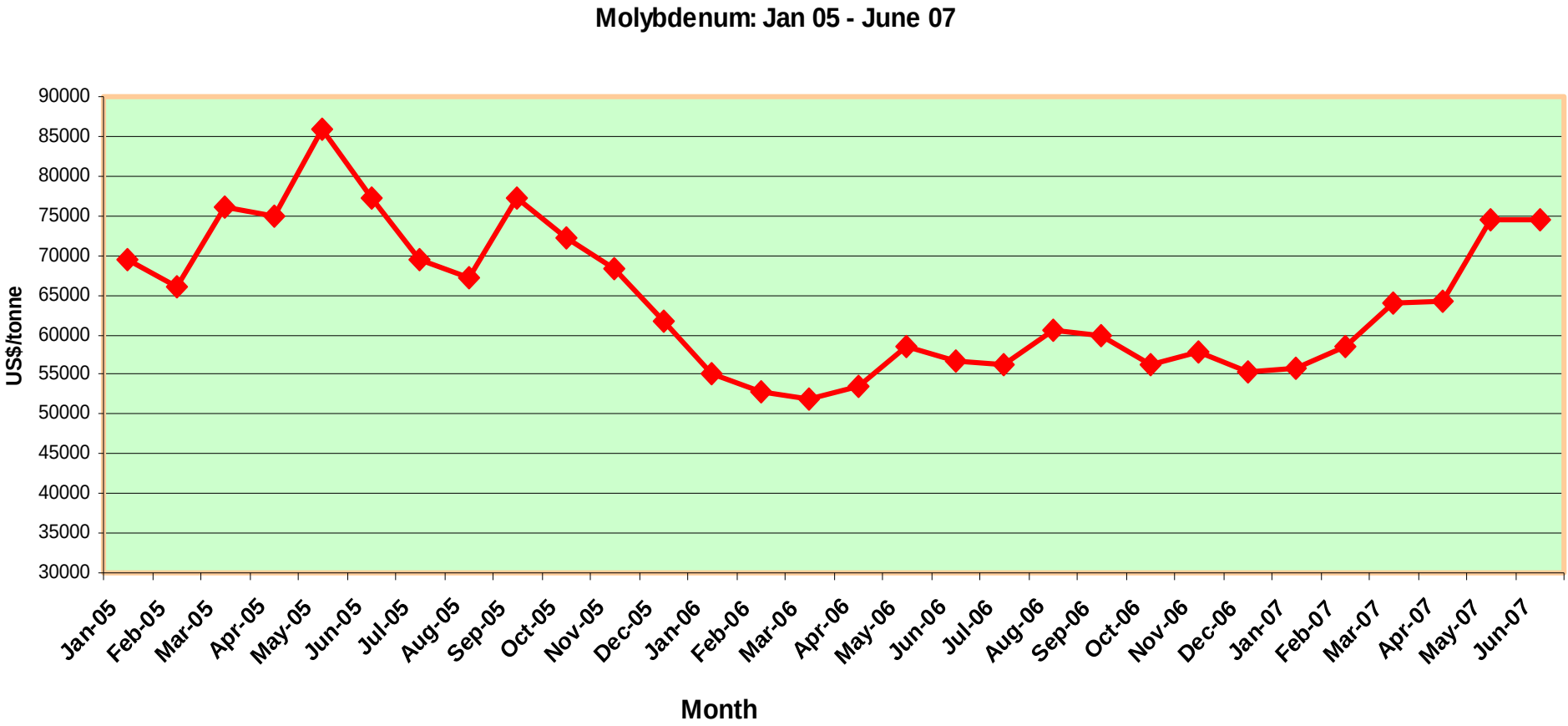

World Stainless Steel Production
30000
25000
20000
15000
10000
5000
0
Tonnes (000
2000
2001
2002
2003
2004
2005
2006
Year
Europe
USA/Can
Brazil
South Africa
Asia
China


Asian SS Prices (304 2B 2mm Coil)
Based on US$ per Tonne
7000
6000
5000
4000
3000
2000
1000
0
Apr-97
Jul-97
Oct-97
Jan-98
Apr-98
Jul-98
Oct-98
Jan-99
Apr-99
Jul-99
Oct-99
Jan-00
Apr-00
Jul-00
Oct-00
Jan-01
Apr-01
Jul-01
Oct-01
Jan-02
Apr-02
Jul-02
Oct-02
Jan-03
Apr-03
Jul-03
Oct-03
Jan-04
Apr-04
Jul-04
Oct-04
Jan-05
Apr-05
Jul-05
Oct-05
Jan-06
Apr-06
Jul-06
Oct-06
Jan-07
Apr-07
Month
Asian CRU SS Prices
AUD$

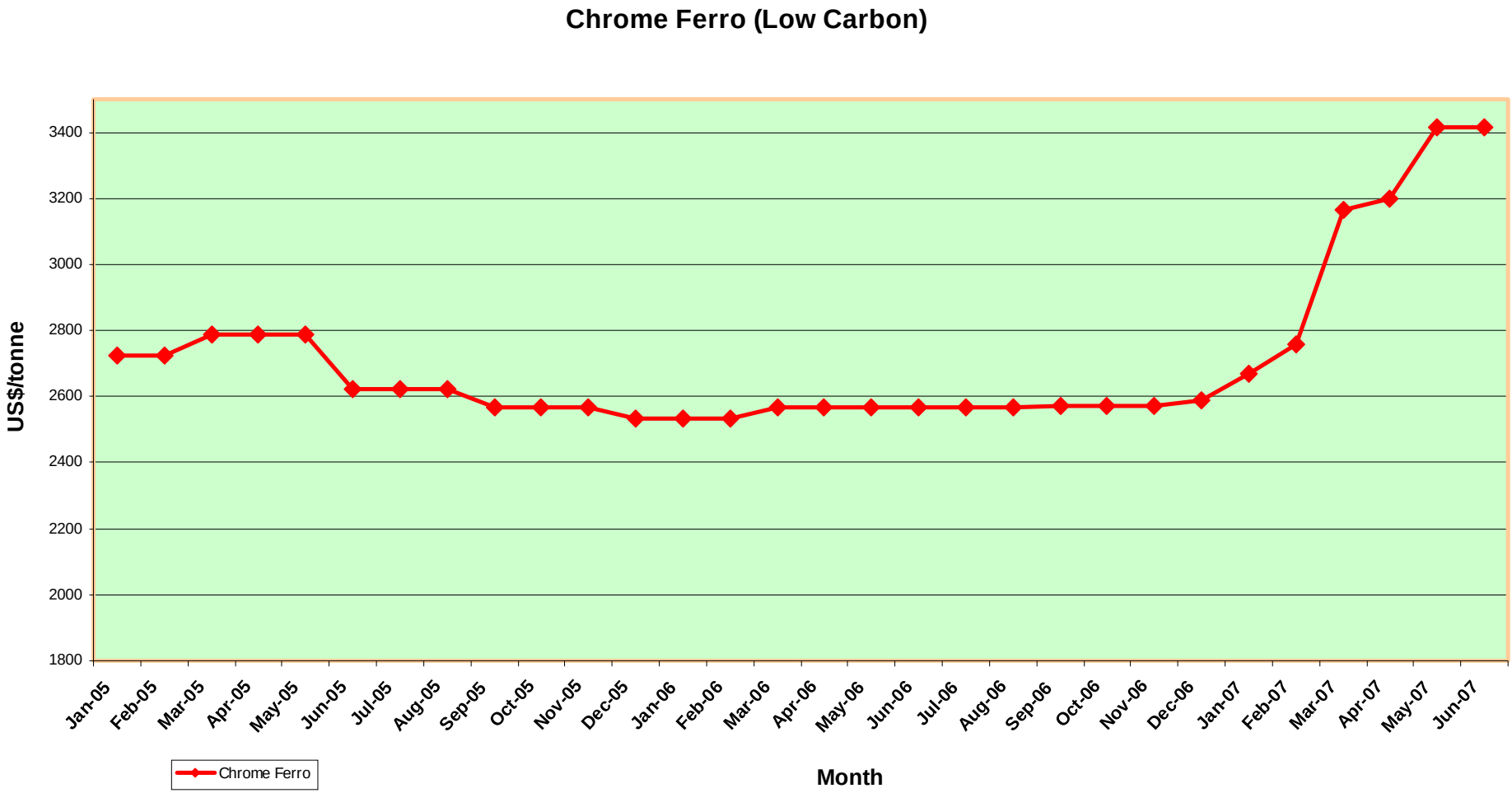
Nickel


Nickel Price V LME Stock
Stock 000's tonne
Price US$ tonne
Month
LME Stock
Nickel Price
0
5000
10000
15000
20000
25000
30000
35000
40000
10000
20000
30000
40000
50000
60000
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07

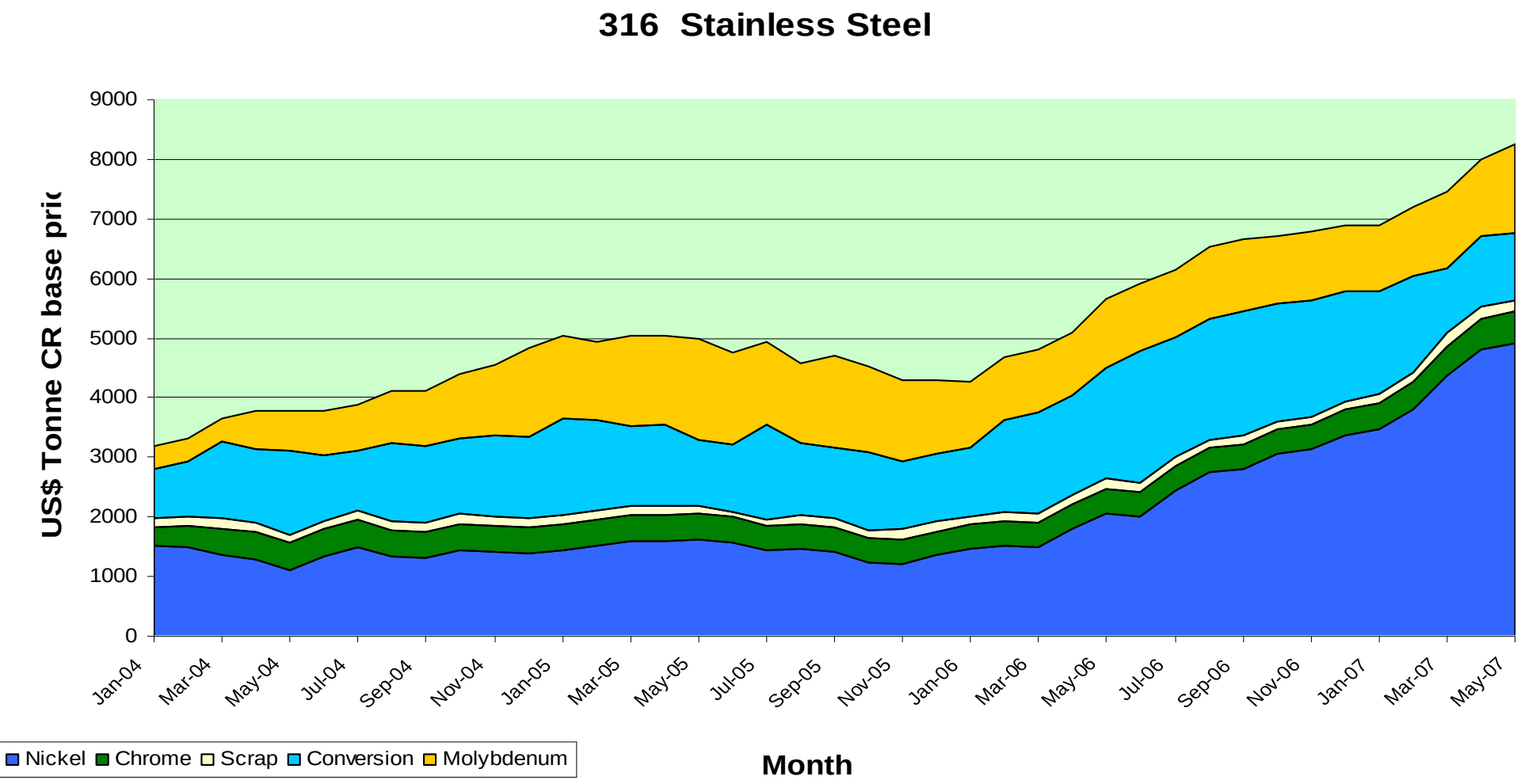
Molybdenum


Molybdenum: Jan 05 - June 07
US$/tonne
90000
85000
80000
75000
70000
65000
60000
55000
50000
45000
40000
35000
30000
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Month

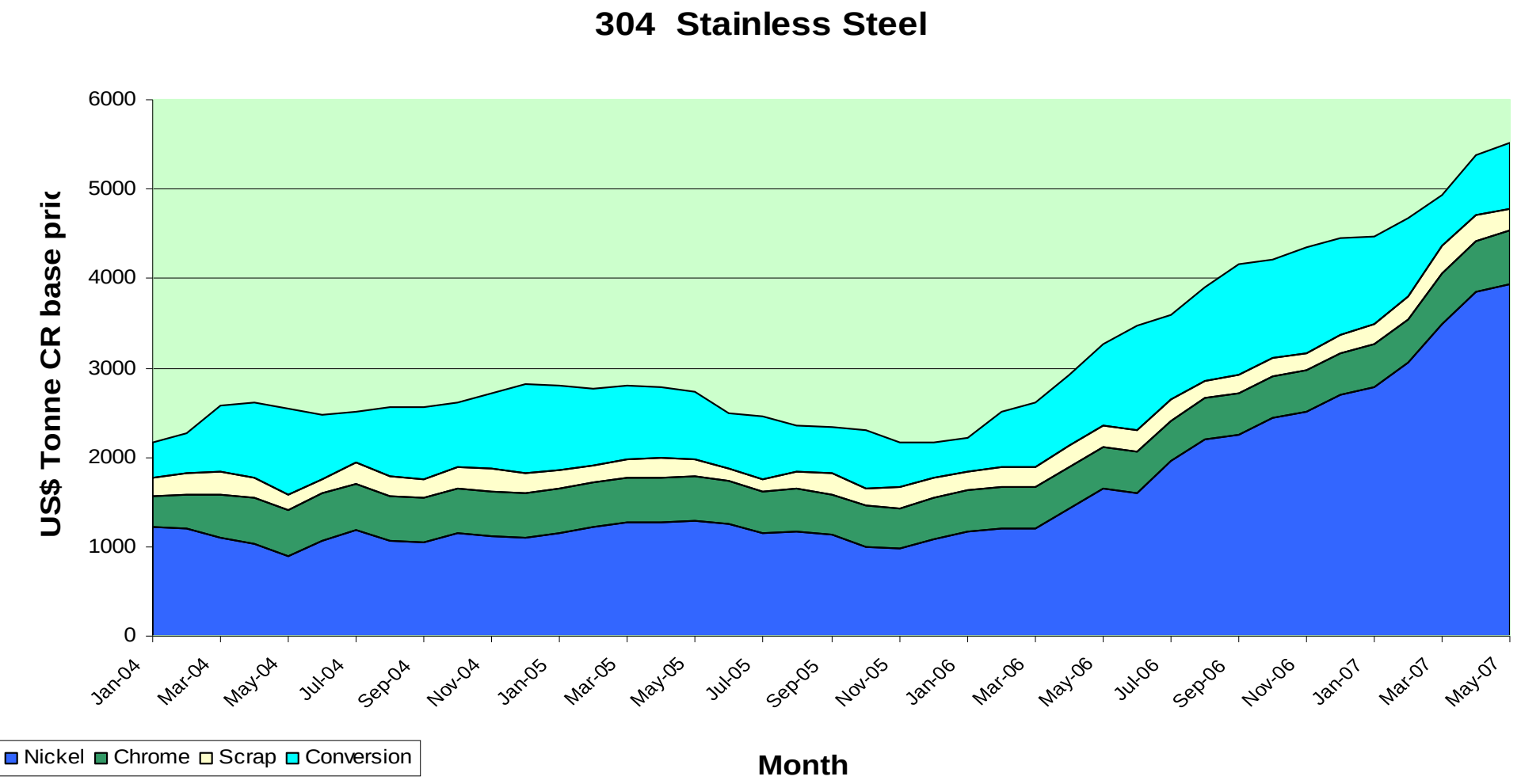
Chromium


Chrome Ferro (Low Carbon)
US$/tonne
3400
3200
3000
2800
2600
2400
2200
2000
1800
Jan-05
Feb-05
Mar-05
Apr-05
May-05
Jun-05
Jul-05
Aug-05
Sep-05
Oct-05
Nov-05
Dec-05
Jan-06
Feb-06
Mar-06
Apr-06
May-06
Jun-06
Jul-06
Aug-06
Sep-06
Oct-06
Nov-06
Dec-06
Jan-07
Feb-07
Mar-07
Apr-07
May-07
Jun-07
Chrome Ferro
Month

316


316 Stainless Steel
US$ Tonne CR base pric
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Nickel
Chrome
Scrap
Conversion
Molybdenum
Month

304


304 Stainless Steel
US$ Tonne CR base pric
6000
5000
4000
3000
2000
1000
0
Jan-04
Mar-04
May-04
Jul-04
Sep-04
Nov-04
Jan-05
Mar-05
May-05
Jul-05
Sep-05
Nov-05
Jan-06
Mar-06
May-06
Jul-06
Sep-06
Nov-06
Jan-07
Mar-07
May-07
Nickel
Chrome
Scrap
Conversion
Month

What Does Nickel Do?

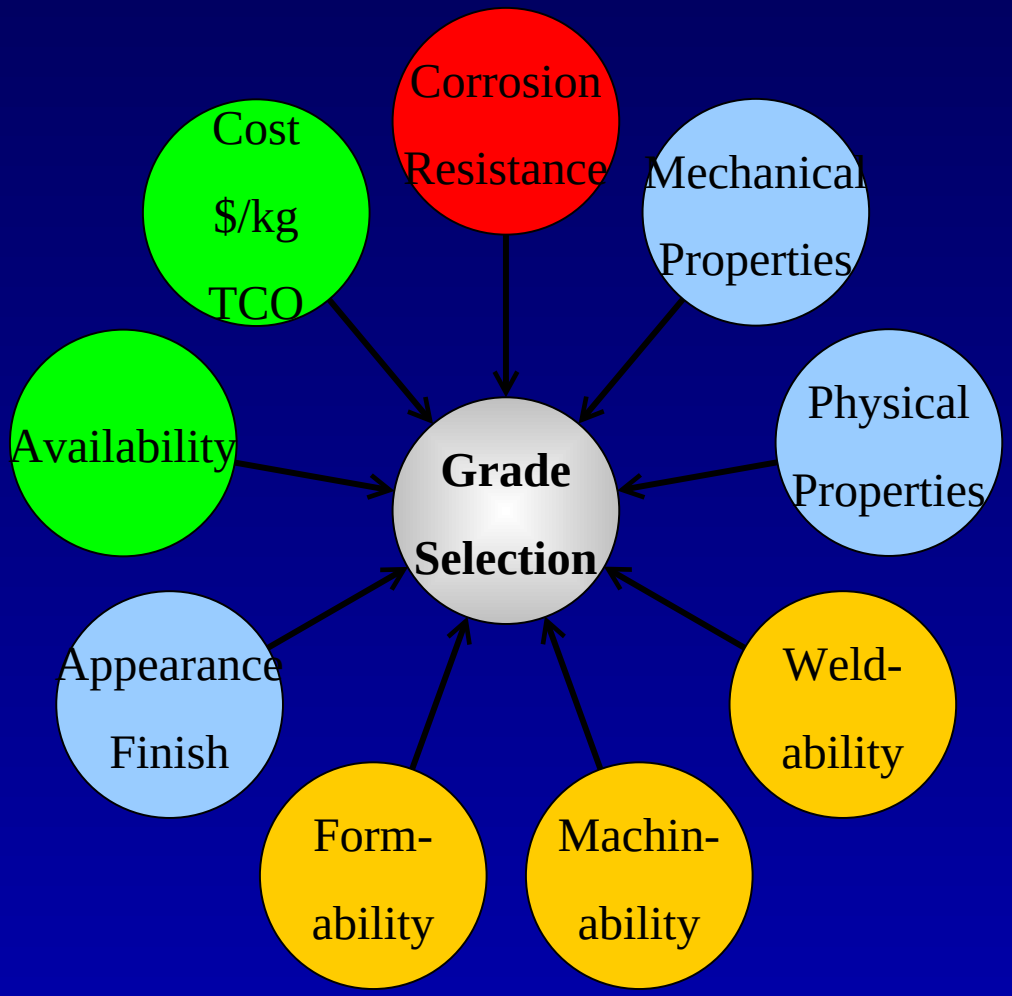
- Stabilises austenite – otherwise stainless is ferritic
  - Austenitic steels are very easy to form and
  - Most austenitics are very easy to weld
- Contributes only slightly to corrosion resistance
  - PRE = %Cr + 3.3x%Mo + 16x%N
- Adds substantially to the cost!

•Carbon, Nitrogen, Manganese and Copper are cheaper austenitising elements than Nickel.

How Grades are Selected

- For **Application** requirements
  - Corrosion resistance – pitting / SSC / general / high temperature
  - Mechanical properties – strength / work hardening / creep / cryogenic toughness
  - Surface finish – appearance / cleanability / corrosion resistance
- For **Fabrication** requirements
  - Weldability
  - Formability (eg deep drawing, bending, hot forging)
  - Machinability
- The **Bottom Line**
  - Available form, size, thickness etc – standard / special
  - Cost - $/kg or Life Cycle Costing or Total Cost of Ownership.

Elements of Grade Selection



Grade Selection
the standard grades

grade	class	PRE	Tensile Strength (MPa)	Form-ability (0-10)	Machin-ability (0-10)	Weld-ability (0-10)
12%Cr	F	11	460	5	6	6
430	F	17	448	4	6	2
303	A	(18)	520	1	8	1
304/L	A	18	520	8	5	8
316/L	A	24	520	8	5	8
2205	D	34	650	5	4	5
904L	A	34	490	7	5	6
6% Mo	A	43	650	6	4	5
Super D	D	43	795	4	3	4

Stainless Steel Grades
A rough map

Austenitic

300-series numbers (304, 316)

- **Low strength, but**
- **Strengthened by cold work**
- **Readily welded &**
- **Readily formed**
- **Nonmagnetic**

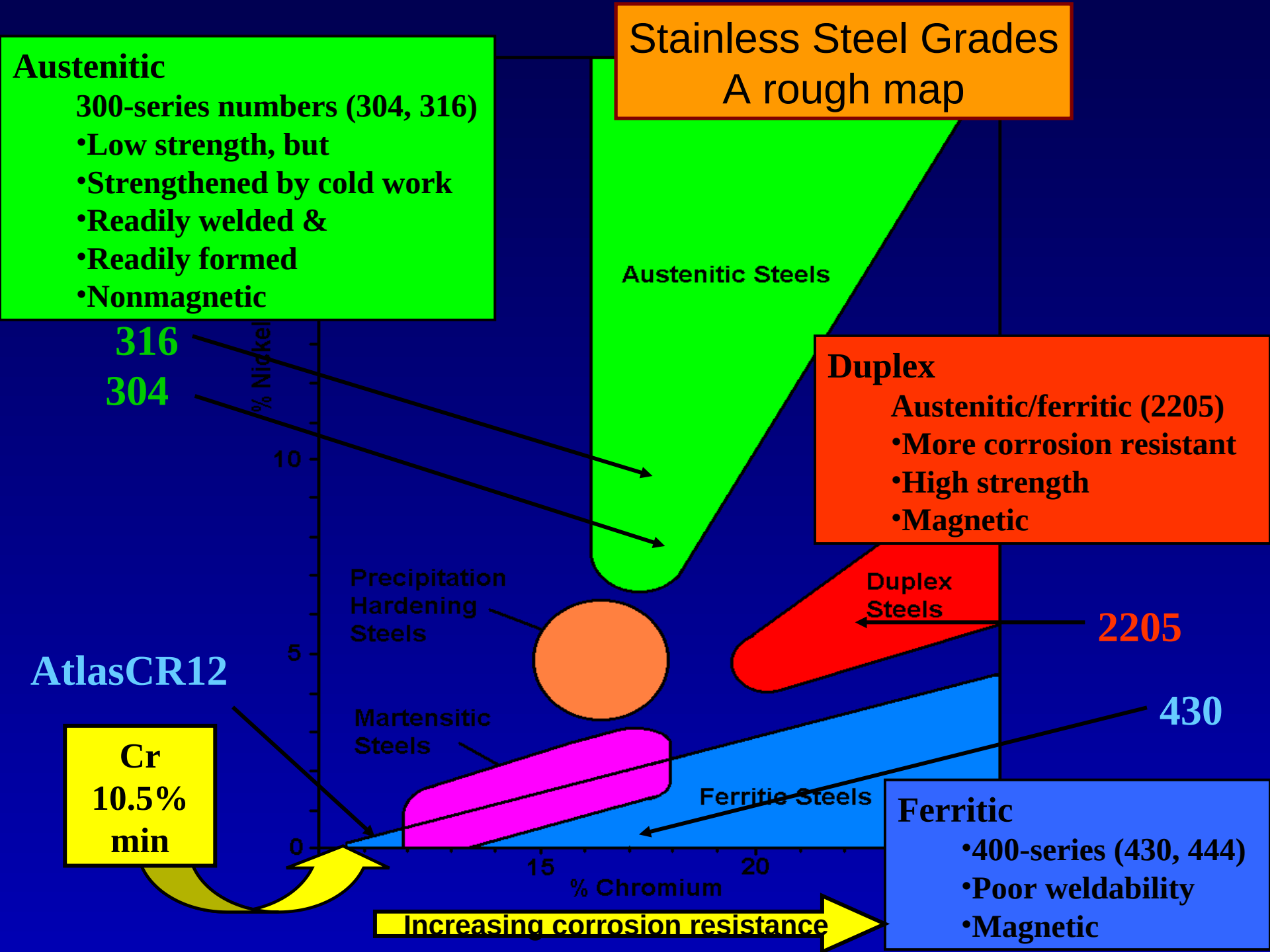
316

304

Duplex

Austenitic/ferritic (2205)

- **More corrosion resistant**
- **High strength**
- **Magnetic**



Ferritic

- **400-series (430, 444)**
- **Poor weldability**
- **Magnetic**

Stainless Grade Properties

- Austenitic
  - Low strength in annealed condition, but
  - Strengthened by cold work
  - Excellent weldability &
  - Excellent formability
  - Nonmagnetic
- Duplex
  - High strength
  - Good weldability
  - Magnetic
- Ferritic
  - Poor weldability – but stabilised grades weldable up to about 2~3mm
  - Magnetic

Traditionally

7 – 25% Ni

Traditionally

4 – 7% Ni

Traditionally

0 – 2% Ni

Nickel promotes Austenite, but there are alternative strategies...

Strategies to Reduce Nickel Cost

- Substitute it (with manganese) – **Austenitic 200-series**
  - 201, 202 standard grades
  - 15/4, 15/1 new offerings

- Reduce it – **Duplex grades**
  - Grade LDX2101 – alternative to 304 (316?)
  - Grade 2304 – alternative to 316

- Eliminate it – **Ferritic grades** (400 series)
  - Grade 430 – good resistance to indoor environments
  - Grade "CR12" – for non-food structural applications
  - Grade 444 – alternative to 316
  - Grade "F21T" – alternative to 304.

Compositions – Traditional & New

		Mn	Cr	Ni	Mo	Ti	N	PRE
CR12	Ferritic		11.5	0.4				11.5
430	Ferritic		17					17
F21T	Ferritic		21			0.4		21
304	Austenitic		18	8				18
2101	Duplex	5	21	1			0.2	24
2304	Duplex		23	4			0.1	25
316	Austenitic		17	10	2			24
444	Ferritic		18		2	0.4		25
2205	Duplex		22	5.5	3		0.17	35

Selection - Austenitics

- Fabrication
  - Easy to weld in all sections
  - Formable hot or cold
  - Machinable
- Availability
  - Widely available in every product
  - Multiple sources of supply
  - All finishes.

Selection - Ferritic grades (430 / “F21T” / 444)

- Fabrication
  - Readily formable
  - Cannot be stretch formed as much as austenitics
  - Weldable up to about 2~3mm thick
    - 430 not generally weldable at all
- Availability
  - Available in sheet or coil
  - Some standardised grades and some proprietary
  - The market is rapidly evolving

Selection – Duplex

- Fabrication
  - Readily formable, but requires more force
  - Readily weldable in all sections
  - Machinable, but high strength makes it more difficult
- Availability
  - Grade 2205 fairly available in plate, sheet, pipe and bar
  - Other grades only available in flat rolled
  - Other grades likely to be by indent only.

Selection – 200-series Austenitics

- Fabrication
  - Readily formable, but require more force
  - Readily weldable in thin sections
  - Machinable
- Availability
  - Not currently ex-stock in Australia
  - Indent is possible.

Selection – “CR12” Ferritic Grade

- 12%Chromium “utility” stainless steel
- Well used in some industries
  - Coal / Iron Ore wagons, Sugar industry, Coal handling equipment etc
- Very useful corrosion resistance
  - In mild environments
  - Where some superficial corrosion is not a problem
- Readily fabricated
  - The ONLY ferritic grade that is weldable in heavy sections
- Readily available in plate and sheet.

Grade Substitutes For 304

- Ferritic “F21T”
  - Only available up to about 2mm thick
- Duplex 2101
  - Not readily available “off the shelf”
  - More difficult to cold form
  - Surface finish not as smooth – 2E not 2B
- Ferritic 430
  - Not readily weldable
  - Only available up to about 1.6mm
  - Less corrosion resistant – do you understand the environment?

Grade Substitutes For 316

- Ferritic 444
  - Only available up to about 2mm thick
- Duplex 2304
  - Not readily available “off the shelf”
  - More difficult to cold form
- Duplex 2205
  - As for 2304, but higher cost .... had problems with 316?
- Austenitic 304
  - An easy change ... But less corrosion resistant – do you understand the environment?

Grade Substitutes For Carbon Steel Coated or Painted

- Ferritic “CR12”
  - Better corrosion resistance
  - Likely to suffer superficial rusting
  - Unlikely to suffer structural corrosion
- Ferritic “F21T”
  - Higher initial cost
  - May be lower life cycle cost

Contacts

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