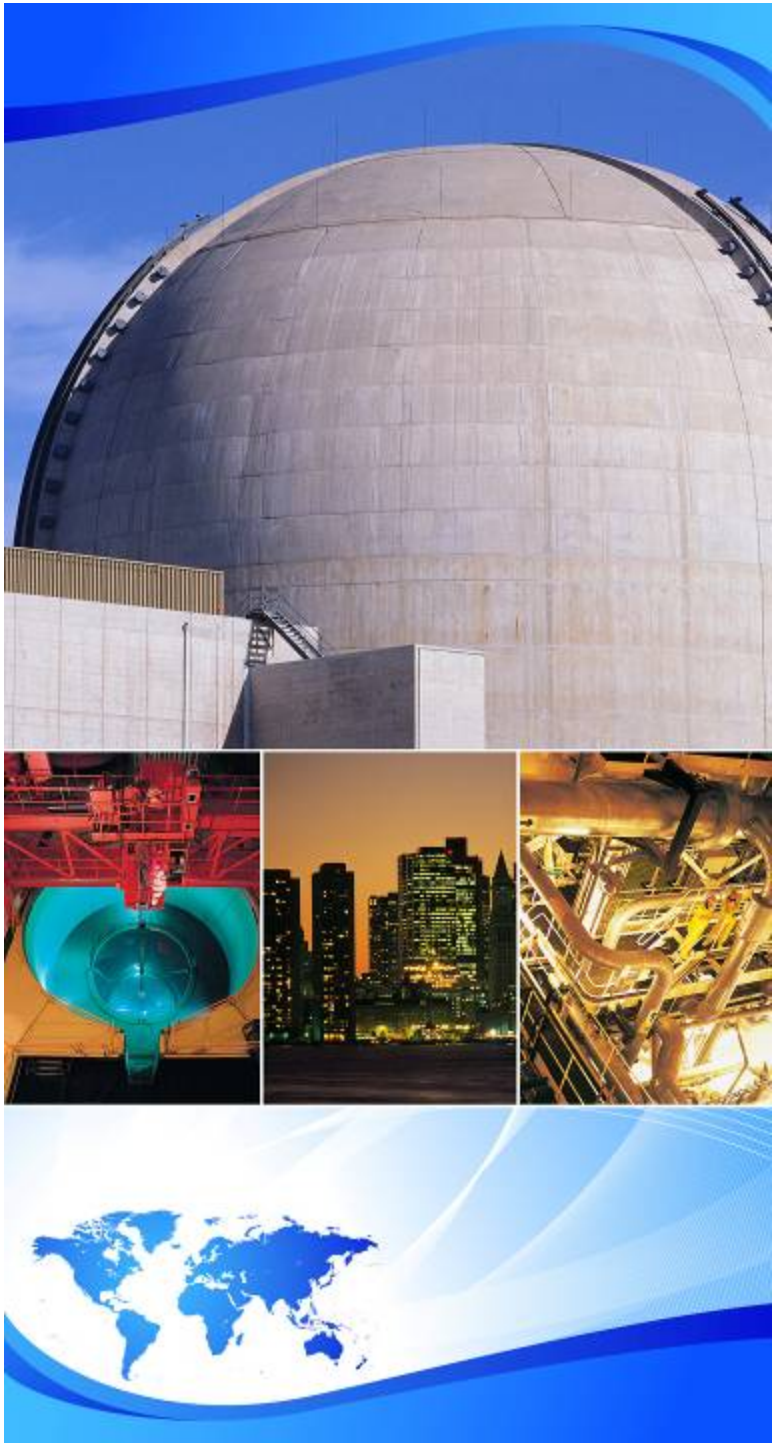

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EPRI Alloy 690 Material Archive

Eric Willis

EPRI Welding & Repair Technology Center

Al Ahluwalia

EPRI MRP

Approach to A690/52/152 Archive System

- Acquire as many as possible A690/52/152 samples that are representative of product forms that will become components in NPPs
- Effort is made to obtain as much details as possible about materials processing for each sample
- CMTRs and mechanical properties are available for most samples in the archive
- Baseline microstructure is available for all samples in the EPRI archive
  - Longitudinal and Transverse cross-section examined
    - Etched and Non-etched condition
    - 25X,50,100,500,1000X photomicrographs taken

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Alloy 690 (SB-167) Tubular CRDM Materials

Sample No.	Product Form	Heat No.
1	Extruded Tubing 4.4 OD. x 2.3 ID.	RF103 (Ling Dong)
2	Extruded Tubing 6.1 OD. x 2.9 ID.	WQ199
3	Extruded Tubing 4.5 OD. x 2.3 ID.	WP787 (CP35/37)
4	Extruded Tubing 4.5 OD. x 1.8 ID.	WQ075 (Diablo Cyn)
5	Extruded Tubing 4.5 OD. x 1.8 ID.	WQ208 (Diablo Cyn)
6	Extruded Tubing 4.5 OD. x 2.3 ID.	RE244 (Salem U2)
7	Extruded Tubing 4.6 OD. x 2.2 ID.	WP785 (Qinshan)
8	Extruded Tubing 4.9 OD. x 2.8 ID.	RF798 (EPR France)
9	Extruded Tubing 4.5 OD. x 2.3 ID.	WQ618 (CP38)
10	Extruded Tubing 4.5 OD. x 2.3 ID.	RF802 (CP38)

Processing Details

- Material melted by Aubert&Duval
  - •Electric arc +ESR
  - •Round bar as forged and peeled
- Extruded and thermal treatment by Valinox
  - •Annealing 1904-1940 F
  - •TT 1324-1342 F for 6hrs/air cool

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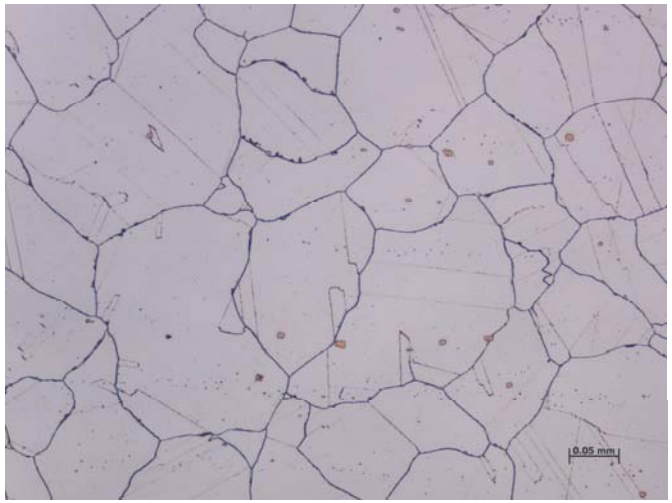
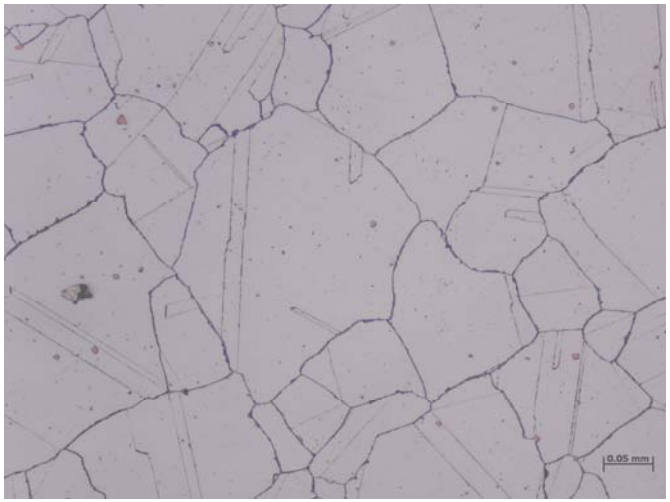
Alloy 690 Tubular CRDM Materials Typical Microstructure

Typical Microstructure Heat No.RE244



Longitudinal



Transverse

Magnification 200X, Electrolytic nital

All material supplied by Valinox

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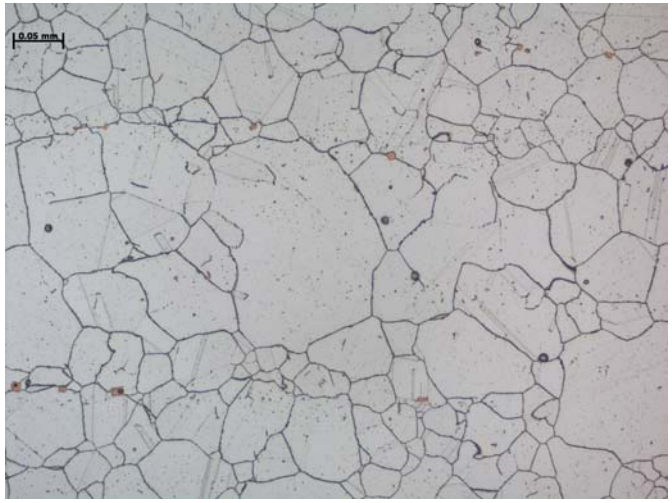
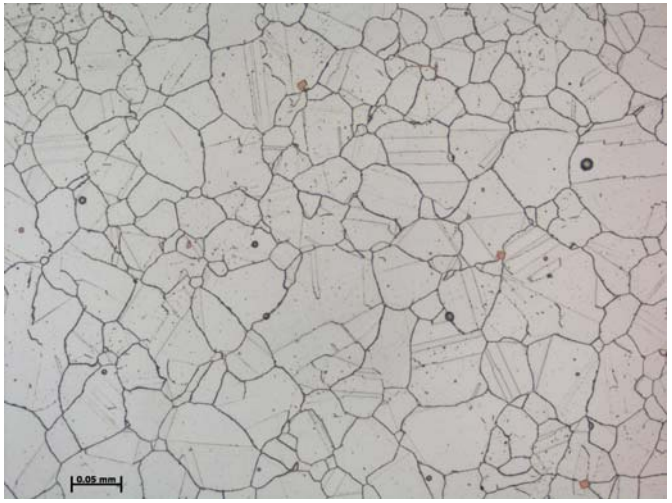
Alloy 690 Tubular CRDM Materials Typical Microstructure

Typical Microstructure Heat No.WP793



Longitudinal



Transverse

Magnification 200X, Electrolytic nital

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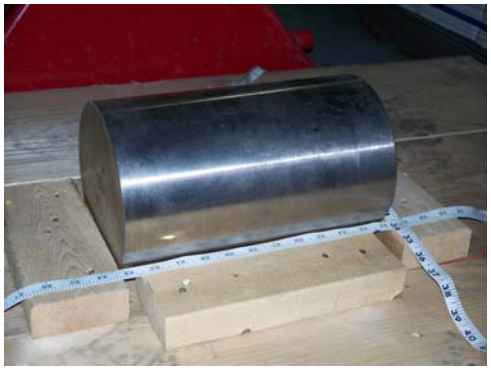
Large Diameter Alloy 690 Billet Stock

Sample No.	Product Form	Heat No.
1	6.8” OD Billet surface ground	X58K-3
2	“ “ “	X87N-1



Processing Details

- Round bar as forged and ground
- Final Heat Treatment

Heat Treatment Temp (ºF)	Time @temp/cooling
Anneal 1885	4hrs,water quenching
TT 1340	5hrs, air cooling

Both heats of material were supplied by Allvac

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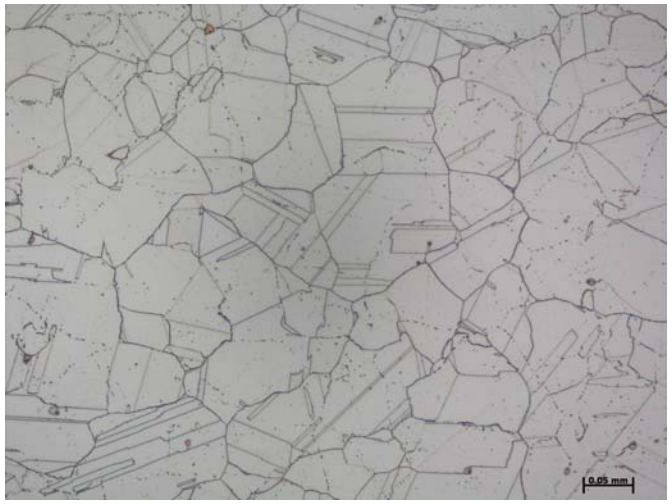
Large Diameter Alloy 690 Billet Stock

Typical Microstructure Heat No. X58K-3



Longitudinal

Transverse

Magnification 200X, Electrolytic nital

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A690 Tubular and Bar Heat Sleeve Stock

Sample No.	Product Form	Heat No.	Supplier
1	Tubing 1.75” OD. x 0.192t	NX3677HK	Special Metal
2	Bar round 1.75” OD.	NX3189HK	Special Metal
3	Bar round 1.75” OD.	NX0643HG1	Special Metal (forged by Coulter Steel)

NX3677HK supplied by APS (Palo Verde)

Both heats supplied by SONG (San Onofre)

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Tubular Heat Sleeve Stock Microstructure

Typical Microstructure for Heat No. NX3677HK (tubing)

Longitudinal

Transverse

Magnification 200X, Electrolytic nital

<u>Processing details</u>: Melting practice (VIM + electroslag remelt)

CMTR list material as Annealed and Stress relieved

Continuous furnace anneal at 1970 for 3.6 min, air cool

No stress relief information given in CMTR

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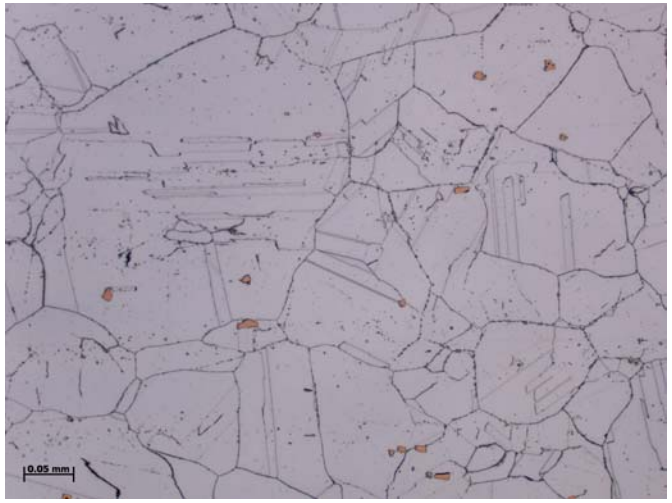
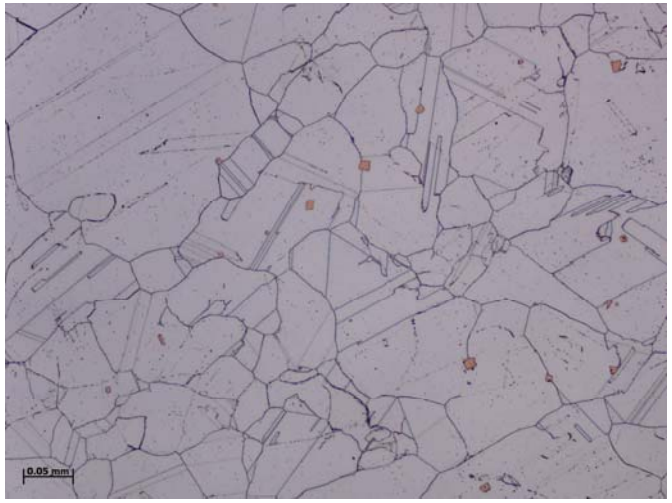
Tubular Heat Sleeve Stock Microstructure

Typical Microstructure for Heat No. NX0643HG1 (Bar)



Longitudinal



Transverse

Magnification 200X, Electrolytic nital

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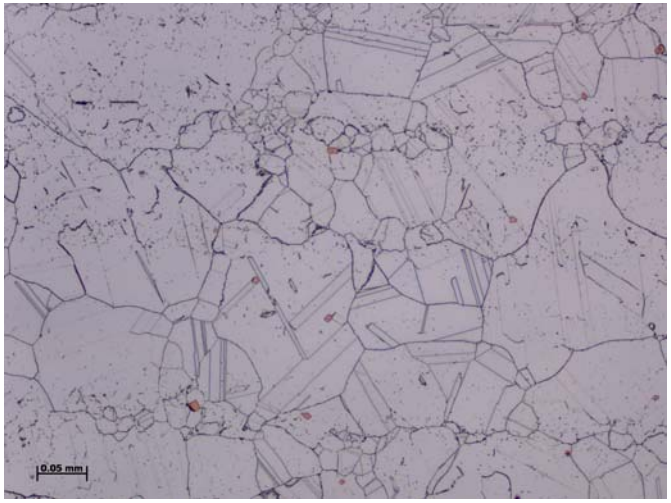
Tubular Heat Sleeve Stock Microstructure



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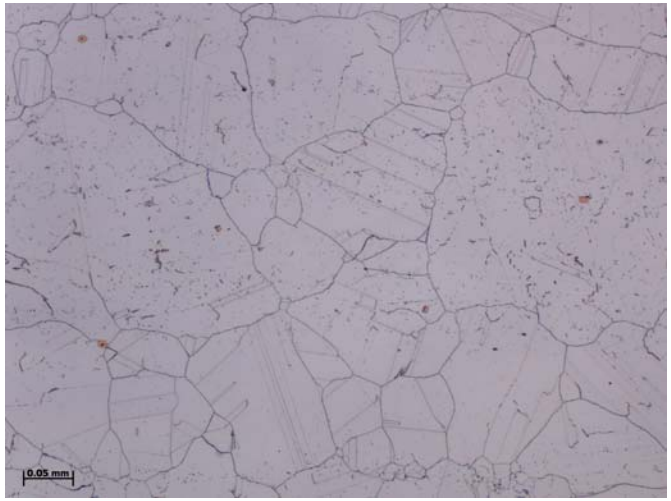
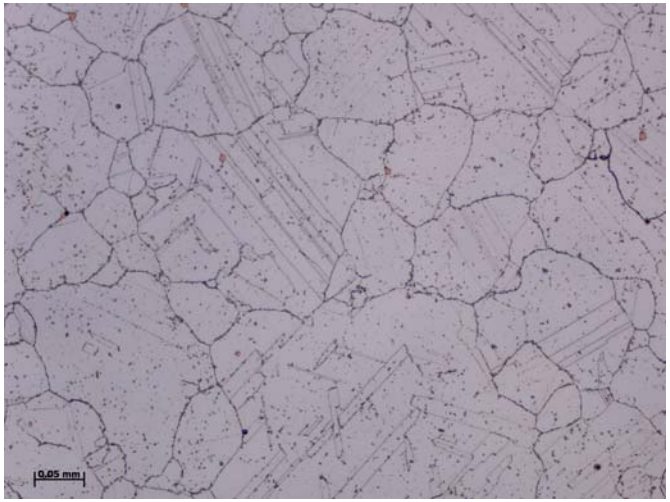


OD

Longitudinal

Typical Microstructure for Heat No. NX3189HK (Bar)



Transverse

Magnification 200X, Electrolytic nital

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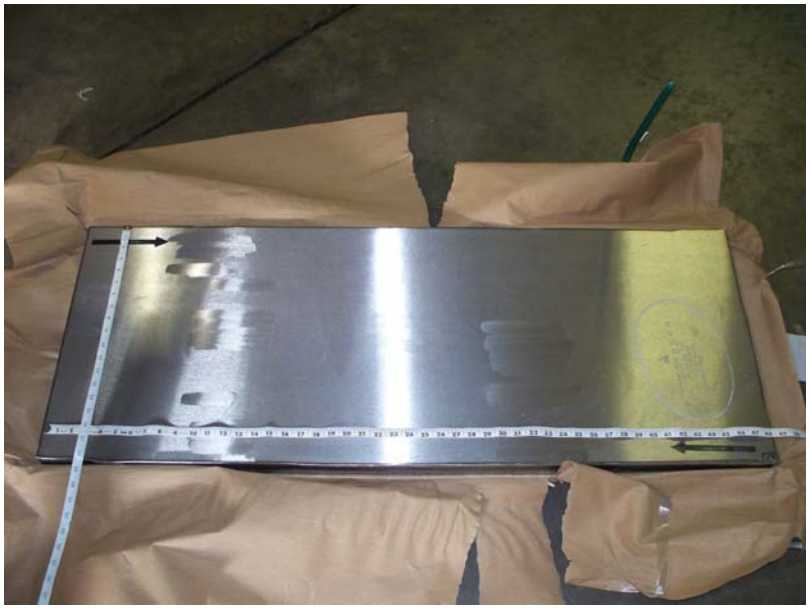
Alloy 690 Plate

Sample No.	Product Form	Heat No.	Supplier
1	Hot rolled plate 2”X18”X48”	114092	ThyssenKrupp



Processing Details

Melting practice: IM +VOD with argon stirring

Hot rolled and ground both sides

Final Heat Treatment

Anneal Temp (°F)	Time @temp/cooling
1880	1hr,water quenching
1328	10hrs, air cooling

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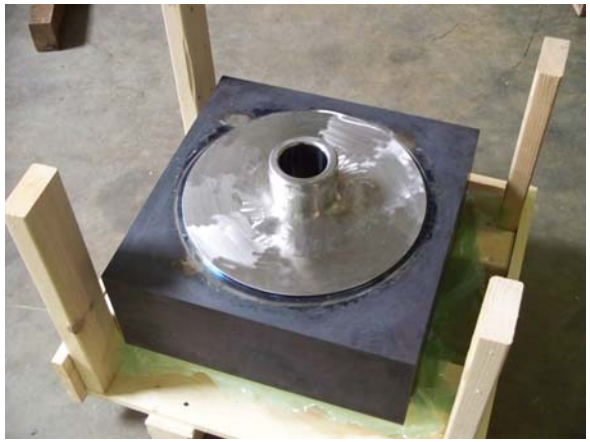
PG&E CRDM Mock-up

- Supplied by PG&E (Diablo Canyon)
- MU performed during replacement head fabrication with typical material
  - Shell (SA-508)
  - CRDM (SB-167)
  - J-weld (Alloy 152)
- Documentation package is in transit



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Alloy 690 Weld Samples

Weldment Type	Size	Purpose of Weldment	Filler Metals	Intent for SCC testing	Status
Narrow Groove Weld (A690 Base Meta)l	18” long x 2.5” high	EN52i	EN82H	Baseline data to help normalize data from different laboratories	In transit to EPRI
	24” long x 2.5” high		EN52M	Obtain SCC data from A690 weld metal that has seen extensive commercial use and known to be susceptible to SCC	In transit to EPRI
			Obtain SCC data on new filler metal with improved weldability relative to EN52/EN52M	To be completed by 1 Nov 09	
Dissimilar Metal v-groove weld (304SS and ASTM 516 Grade 70 Base Metal)	12” long x 2.5” x 6” wide	Provide SCC samples from a constrained, dissimilar metal weld to investigate the effects of dilution on SCC rates	EN52M	Obtain SCC data from A690 weld metal that has seen extensive commercial use and known to be susceptible to SCC	In transit to EPRI
			E-152M		In transit to EPRI
			EN52i	Obtain SCC data on new filler metal with improved weldability relative to EN52/EN52M	To be completed by 1 Nov 09
			E-152i		To be completed by 1 Nov 09

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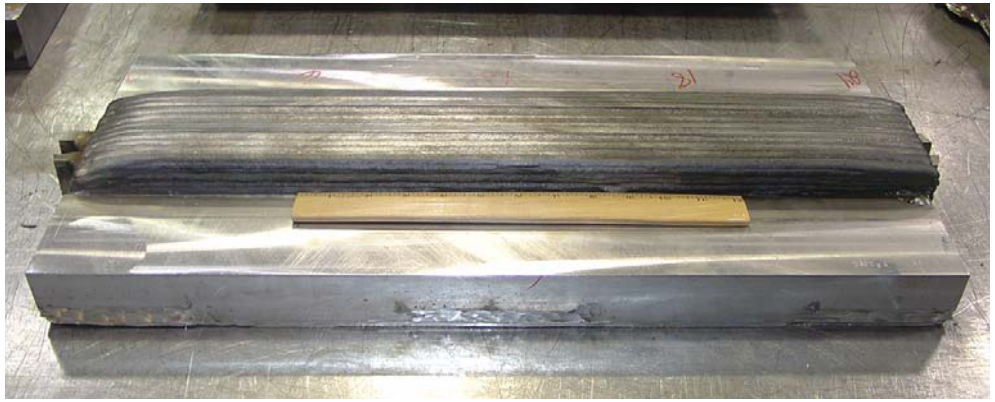
Alloy 690 Weld Samples



DJI 19508A – EN52M Narrow Groove Weld

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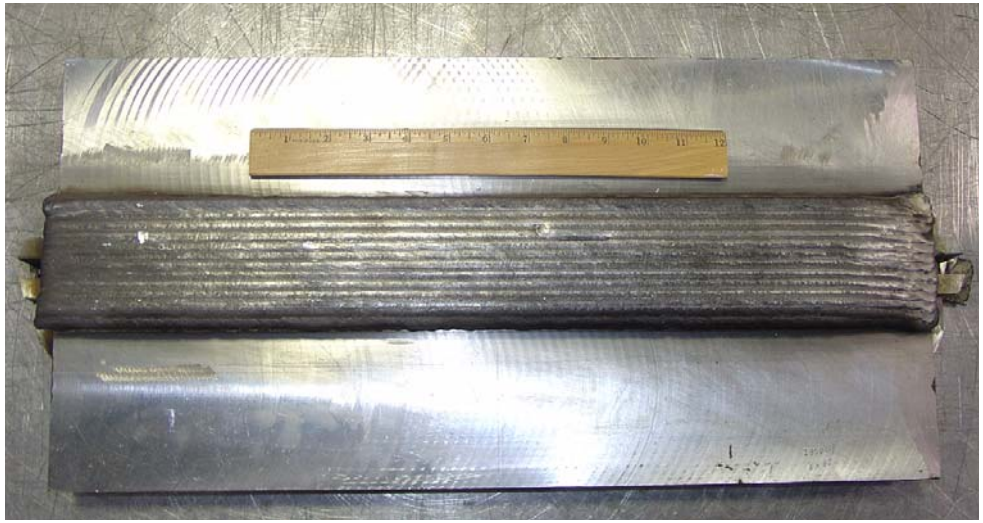
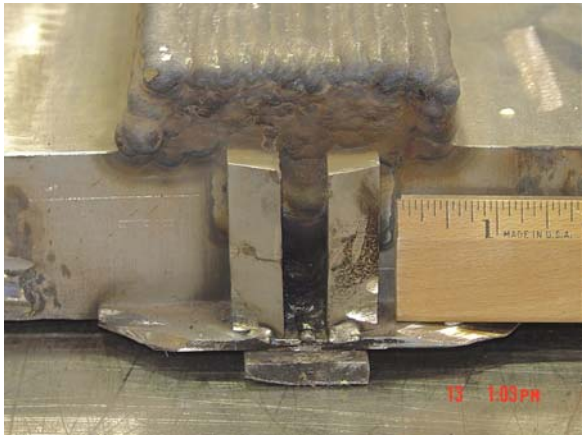
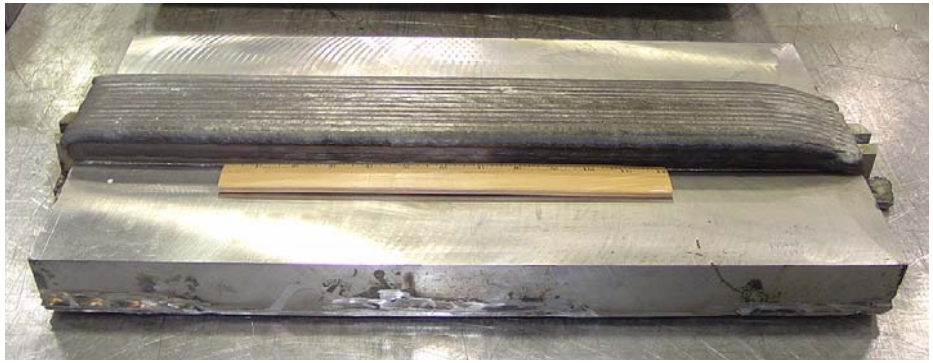
Alloy 690 Weld Samples







DJI 19508B – EN82H Narrow Groove Weld

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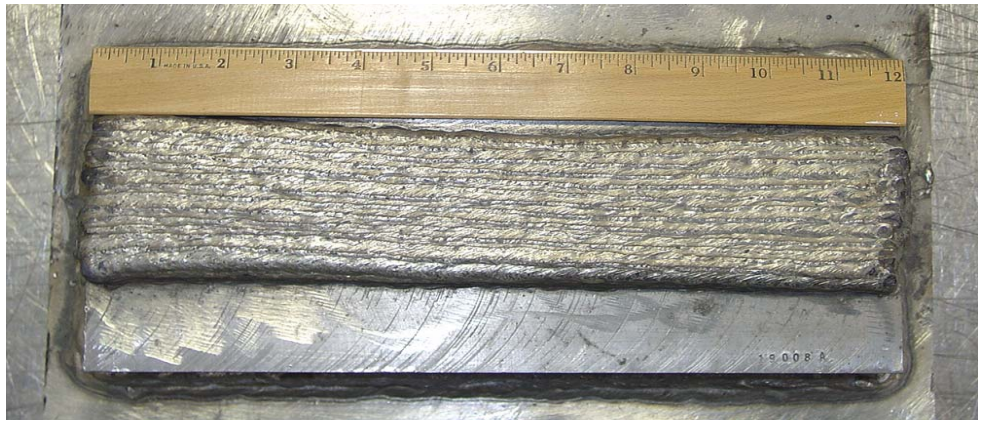
Alloy 690 Weld Samples



DJI 19008A – 152M Dissiimilar Metal v-groove Weld

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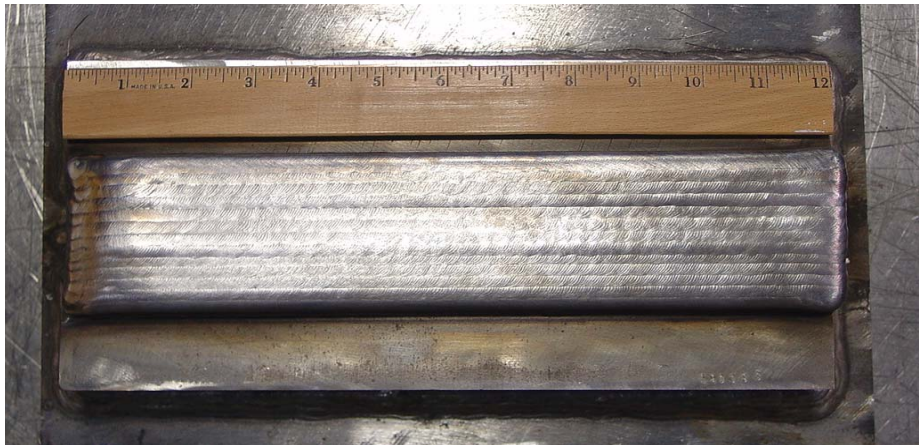
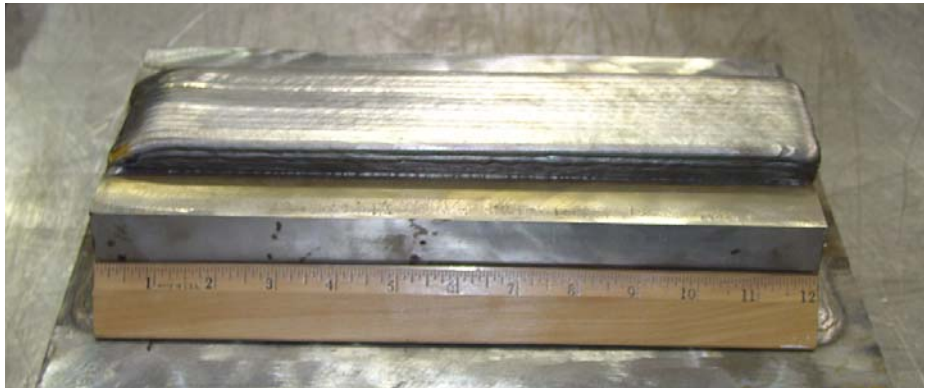
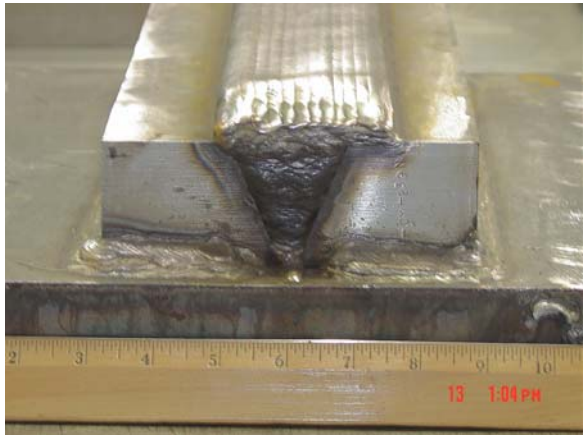
Alloy 690 Weld Samples







DJI 19008B – EN52M Dissimilar Metal v-groove Weld

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