



ELLWOOD  
SPECIALTY  
STEEL

# ExELL TUF-DIE

## Hot Work Tool Steel

### Surface Treatments

Surfaces of *ExELL TUF-DIE* can readily be chrome plated, nitrocarburized or nitrided by all commercial processes.

Care must be taken to avoid hydrogen embrittlement in chrome plating. Temper at 400F for 4 hours after plating.

Avoid excessive concentrations of nitrogen during various nitriding processes to avoid white layer and excessive network.

Generally, case depths greater than 0.010" are not recommended for hot work applications

### Tool Making

For any additional information to include machining, welding, grinding, or EDM, please contact Ellwood Specialty Steel direct at 800-932-2188

## CAPABILITIES

*Ellwood Specialty Steel* is a fully integrated producer of a wide range of specialty tool steels.

Our ExELL grades are made with the most advanced steel making facilities. Our steel making expertise and capability is further enhanced from a long forging history with

optimum forging and heat treating practices to develop very special material characteristics of product uniformity, cleanliness, machinability, polishability, strength, toughness, hardenability and other steel properties. All this from production facilities certified to ISO 9002.

## QUALITY ASSURANCE

Ellwood Specialty Steel is committed to providing products and services which will consistently meet or exceed all quality and performance expectations. We will provide customer and technical service that will ensure complete satisfaction

Being a very flexible provider, Ellwood Specialty

Steel will establish product programs to fully support industry or customer requirements. Our extensive stock programs are supported by very short mill lead times of custom forged products. Customized stock programs are and can be available for specific customer needs.

This information is intended to provide general data on our products and their uses and is based on our knowledge at the time of publication. No information should be construed as a guarantee of specific properties of the products described or suitability for a particular application. Ellwood Specialty steel reserves the right to make changes in practices which may render some information outdated or obsolete. Ellwood Specialty Steel should be consulted for current information and/or capabilities.

## ELLWOOD SPECIALTY STEEL

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*ExELL TUF-DIE* is a premium quality hot work die steel manufactured for high demanding tooling requirements.

*ExELL TUF-DIE* is a modified version of AISI H-11 to promote both added heat resistance and toughness when compared to H-13. This chromium-molybdenum-vanadium alloyed tool steel is characterized by the following general properties:

- ★ High temperature strength
- ★ Very good toughness and ductility
- ★ Resistance to thermal shock and fatigue
- ★ Easy heat treatment
- ★ Good machinability

## IMPROVED MANUFACTURING

*ExELL TUF-DIE* is manufactured to standards of very high tooling quality for optimum service performance. Material is produced with excellent cleanliness, structure uniformity and mechanical properties.

Steel manufacture includes:

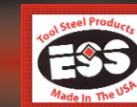
- ★ Special steel melting and refining
- ★ Very precise chemistry control
- ★ Heavy forging reductions
- ★ Special mill thermal treatment
- ★ Complete manufacture, testing and quality assurance within facilities certified to ISO 9002



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## TYPICAL ANALYSIS

C	0.39	Cr	5.07
Si	0.25	V	0.65
Mn	0.34	Mo	1.80





### APPLICATIONS

ExELL TUF-DIE is used in die casting applications where a higher level of heat resistance along with good toughness and ductility are required.

ExELL TUF-DIE is manufactured to meet the demanding criteria of NADCA #207, Chrysler NP2080, GM HPDC G2 and other specifications for premium material quality.

ExELL TUF-DIE is also used in most other hot work applications such as hammer die inserts, press dies and inserts, HERF dies and punches, extrusion tooling components as well as plastic molds and in critical cold or hot knife, punch or holder applications where an optimum combination of strength and toughness are required.

Part	Typical Hardness, HRC
Sprue Parts	46-48
Cores	46-50
Fixed Inserts	46-50
Dies	42-48

Work Material	Typical Hardness, HRC
Aluminum	44-52
Copper Alloys	44-52
Steel	40-50

Component	Aluminum	Copper	Steel
	HRC	HRC	HRC
Dies	46-50	44-48	44-48
Liners, stems	42-50	42-48	42-48

### PHYSICAL PROPERTIES

#### Density, lbs/cu.in.

70F.....0.281  
750F.....0.277  
1450F.....0.272

#### Thermal Conductivity, BTU in/ft<sup>2</sup> hr F

70F.....180  
750F.....185  
1450F.....195

#### Modulus of Elasticity, psi

70F.....29,400,000  
750F.....29,500,000

#### Coefficient of Thermal Expansion, in/in/F

70-450F.....0.000070  
70-1450F.....0.000077

### MECHANICAL PROPERTIES

#### Tensile Properties, Room Temperature

	52 HRC	46 HRC
Tensile Strength, psi	260,000	205,000
0.2% Yield Strength, psi	220,000	185,000
% RA	46	56
% Elongation	10	12

Test Temp F	Yield Strength psi	Tensile Strength psi	RA %
1000	110,000	140,000	60
1100	85,000	115,000	70
1200	45,000	70,000	80
1300	20,000	30,000	90

### HEAT TREATMENT (General Recommendations)

#### STRESS RELIEVING

After rough machining an annealed component, heat the part to 1200F, equalize and hold 1-2 hours. Furnace cool to 900F and then air cool to room temperature.

#### Critical Temperatures

Ac<sub>1</sub> - 1560F  
Ac<sub>3</sub> - 1740F  
Ms - 570F

#### ANNEALING

With a protective atmosphere or vacuum furnace, heat slowly to 1560F. Equalize and hold one hour per inch of thickness. Furnace cool 20F/hr to 1100F and equalize. Cool freely in air to room temperature. Hardness will be 229 HB maximum.

### HARDENING AND QUENCHING

(Protect against decarburization and oxidation during austenitizing)

#### Preheating

Heat to 1200F and equalize. Continue heating to 1550F and equalize. Complete heating to hardening temperature.

Hardening Temperature	Hold Time*	As-Quenched Hardness, HRC
1870F	30 min	53 ± 2
1900F	15 min	54 ± 2

\*Hold time = time at temperature after tool is fully heated through

#### Hardening

Typical austenitizing range is 1850 - 1900F. Hardening temperature can be adjusted to develop added heat resistance. A hardening temperature of 1870F is normally used for most applications

#### Quenching

Quenching should be performed as rapidly as possible without promoting excess movement or cracking. Typical quenching media include:

- \* High speed gas with sufficient positive pressure and circulation in a vacuum furnace
- \* Circulating air/atmosphere
- \* Martempering bath or fluidized bed at 575-1020F, then air cool
- \* Warm oil

Temper as soon as part reaches 120-150F

#### Tempering

Temper immediately after quenching to about 150F. Temper a minimum of two times with intermediate cooling to room temperature.

Choose the tempering temperature to develop required hardness. ExELL TUF-DIE should be heated to the desired tempering temperature and held a minimum of two hours. Air cool to room temperature. Check hardness and adjust temperature for additional tempering operation(s). Repeat for added tempers.

Typical tempering temperature responses follow. Do not retemper in the range of 800-975F to avoid temper embrittlement.

Tempering Temperature	Harden 1870F HRC	Harden 1900F HRC
480F	52	53
1000F	53	54
1050F	51	53
1100F	46	49
1150F	42	46
1200F	35	37

