



**World Oil<sup>®</sup> HPHT**  
**DRILLING, COMPLETIONS & PRODUCTION CONFERENCE**

**September 26–27, 2017**

Norris Conference Centers – CityCentre, Houston, Texas

[HPHTConference.com](http://HPHTConference.com)

# Qualification of High Pressure, High Temperature Threaded and Coupled Workover/Completion Riser

Mike Tricarico

Riser Product Manager USA

Vallourec

# Agenda

- Specific approach and environment for the Work Over Riser
- Environment to Design
- Design to Test Program – combining multiple programs
- Testing Results

# The Workover Environment

# Work Over Riser Environment

- Gulf of Mexico project in over 7,000ft water depth
- 15,000 psi working Pressure
- 250°F max working temperature (design class U)
- 1mm Corrosion Tolerance
- 1,500kips maximum operation tension
- Design and testing requirements per ISO13628-7/API17G (2005) & ISO/FDIS 13679:2011 CALIV modified
- 25 Make & Break Cycles
- NACE Region 3 Material
- SAF of 1.5 vs. DNV B1 curve in air

# From the Workover Environment to Design



# Riser Design

- Material Selection
  - Outer Diameter/Wall Thickness must meet the “working pressure” ISO13628-7/API17G
  - Must include all the design factors of temperature, corrosion tolerance, drift, wall thickness, and tensile strength

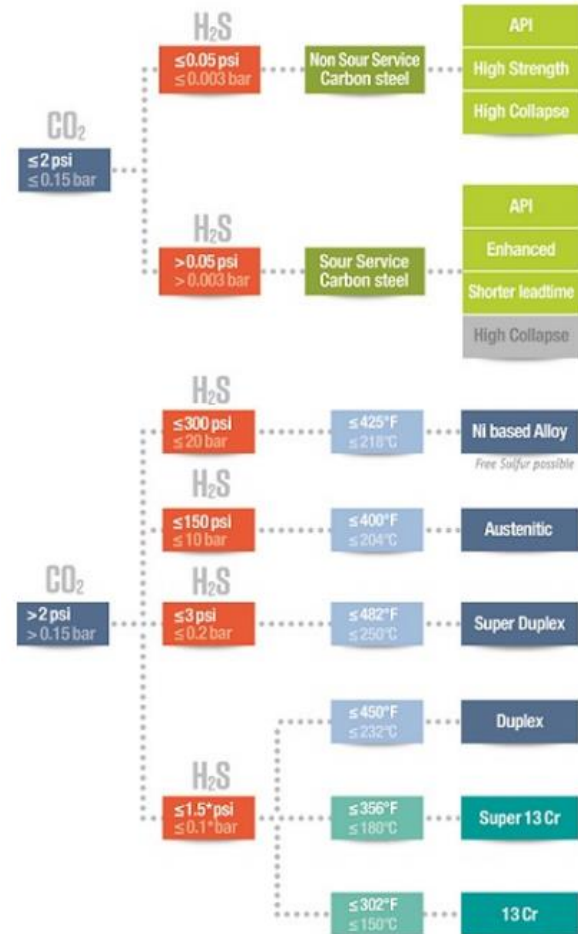
INPUT TABLE	
<b>Max working temperature</b>	250 deg F
<b>Wt tolerances</b>	10.0%
<b>Thickness corrosion allowance</b>	1 mm

Tension efficiency	cross-sectional area (with corrosion tolerance)	Nom Outer Diam	Nominal thickness	Drift Diameter	Thickness for burst calculation	Temp. Red. Factor 0.91			
						Max. working pressure ISO 13628-7			
						80000	95000	110000	125000
0.88	17.09	6 5/8	1	4.5	0.861	15697	17984	21874	23314
0.88	14.04	7	0.75	5.375	0.636	10497	11987	13790	15588
0.88	15.76	7	0.85	5.175	0.726	12158	13889	15976	18089
1.00	18.23	7	1	4.875	0.861	14734	16888	19884	21889
1.00	20.11	7 5/8	1	5.5	0.861	13372	15283	17875	19889

Tensile Strength ISO 13628-7			
80000	95000	110000	125000
731,756	868,960	1,509,247	1,143,369
599,685	712,126	824,567	937,008
673,196	799,421	925,645	1,051,869
884,581	1,050,440	1,216,299	1,382,158
976,124	1,159,148	1,342,171	1,525,195

# Riser Design

- Material Selection
  - Ensure sour service compliance with selected grade, especially coupling stock
  - Ensure pipe can be manufactured with enhanced wall thickness tolerances

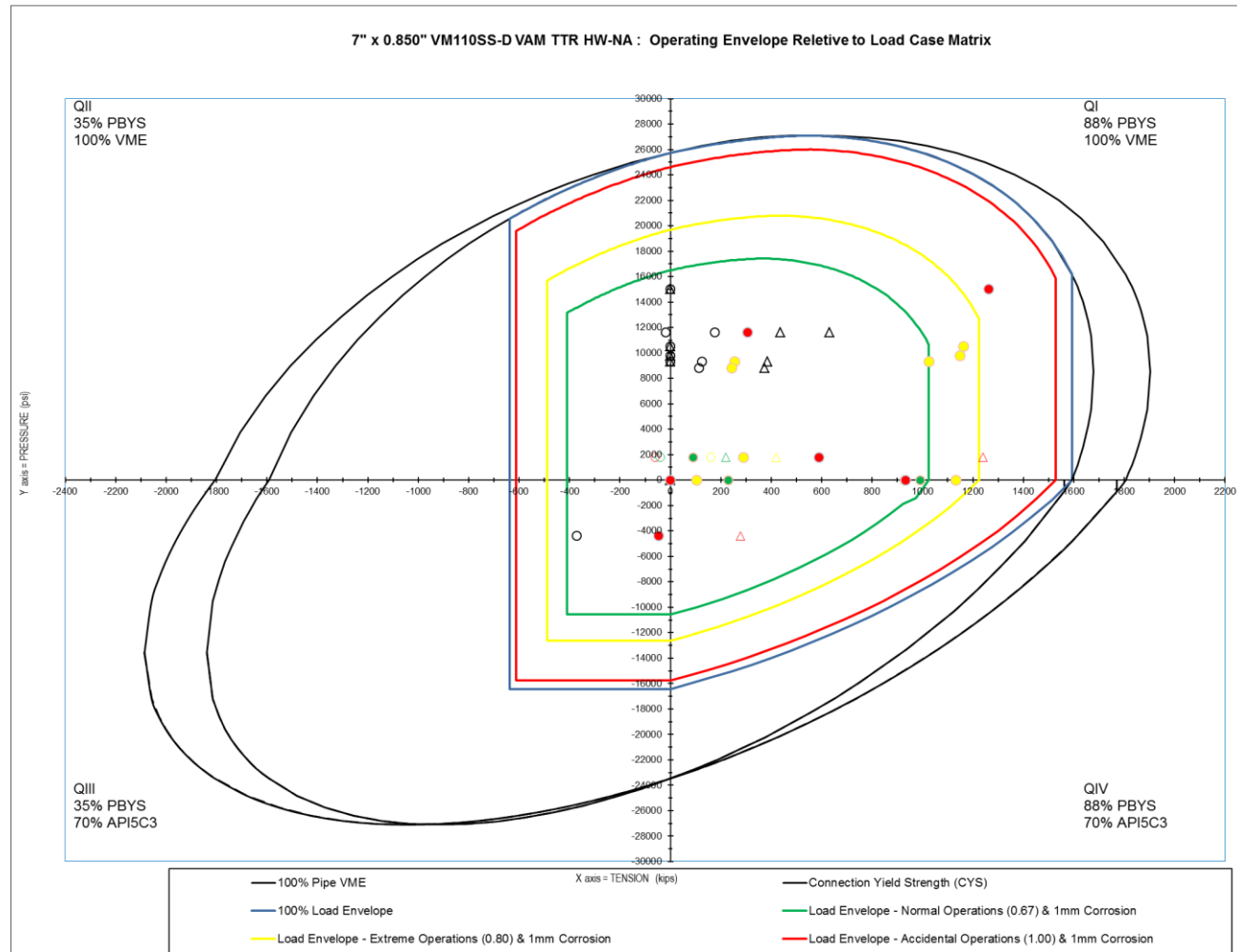




# Riser Design

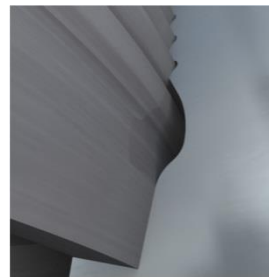
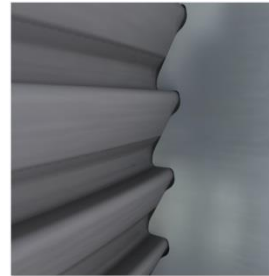
- Material/Connection Selection

- An envelope of the selected connection was created showing the different levels of operating, extreme, and accidental loads.
- The various loads were then plotted against the Von Mises Ellipse to ensure all loads fell within the allowable envelopes



# Riser Design

- Connection Selection
  - VAM® TTR was selected to meet the connection requirements.
  - The high fatigue performance and internal/external metal to metal seal met all of the environmental and performance criteria
  - Strong field history also made it a good option for the end user

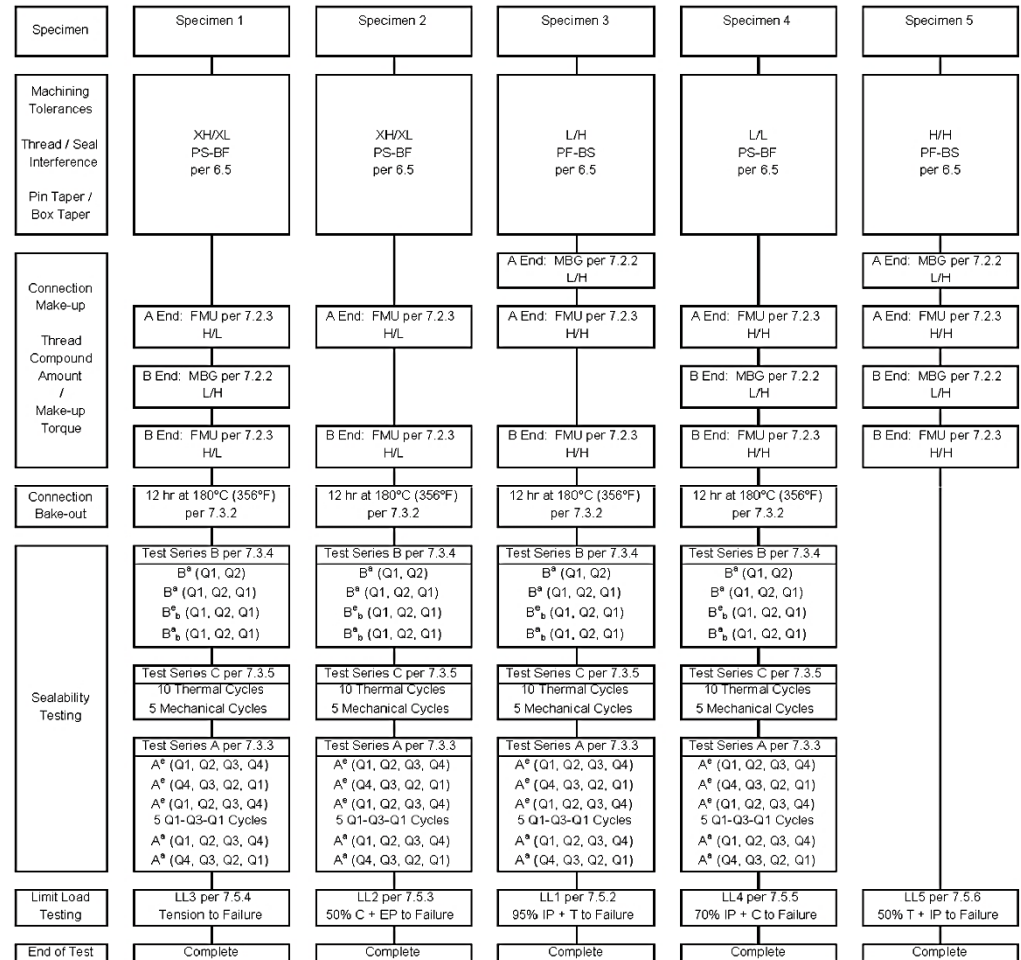


# Design to Test Program – combining multiple programs

# Testing Program

## ISO/FDIS 13679:2011 CALIV

- Connection Qualification
  - Connection primary qualification was required by the end user to follow the Connection Assessment Level (CAL) IV protocol, without elevated temperature series A



# Testing Program

- Connection Qualification
  - Testing requirements of API 13679/API 17G 2006 were also required. The protocol is not as prescriptive as other specifications, so required careful design of a testing program to meet all of the requirements.

## ISO13628-7/API 17G 2006

Table I.1 — Example of the use of test specimens

Specimen 1	Specimen 2	Specimen 3
Functionality tests	Functionality tests	Functionality tests
Pressure cycling test	External pressure test	External load cyclic test
External load cyclic test	External load cyclic test	External load cyclic test to failure
Internal pressure (burst) test	External load testing including test to structural failure	—

# Testing Program

Static Testing - Per ISO/FDIS 13679 & ISO13628-7 (2006) - modified testing

- Combining the two programs
  - Sealability Specimens followed 13679 protocol, but with “combined specimens” to take advantage of two sides on a threaded and coupled connection, but with increased Make and Break requirements per 17G
  - The M&B specimen followed 17G requirements of interchanging sides, multiple hydro tests, and multiple gas tests
  - Six (6) fatigue tests (not shown) were also performed to satisfy the requirements of API 17G

	Specimen 1 (ISO Specimens 1 & 2)		Specimen 2 (ISO Specimens 3 & 4)		Specimen 3 (ISO Specimen 5)	
	A end	B end	A end	B end	A end	B end
Interferences (Thd / seal)	XH / XL	XH / XL	L / H	L / L	H / H	L / L
Functionality Tests (ISO 13628-7 I-8)	Standard M&B Testing Per ISO13679 up to 25 M&B's	FMU	Standard M&B Testing Per ISO13679 up to 25 M&B's	FMU	Make Up	
					Hydro Test	
					Gas Test	
					5 M/B	
					Hydro Test	
					5 M/B (Interchange Sides)	
					Hydro Test	
					5 M/B (Interchange Sides)	
					Hydro Test	
					5 M/B (Interchange Sides)	
					Hydro Test	
Gas Test (FI)						
Bake Out	12 Hr @ TBA		12 Hr @ TBA		N/A	
Sealability Tests	Series B		Series B		N/A	
	Series C		Series C		N/A	
	Series A		Series A		N/A	
Load Limit	Tension to Failure		95% IP + T to failure		50% T + IP to failure	

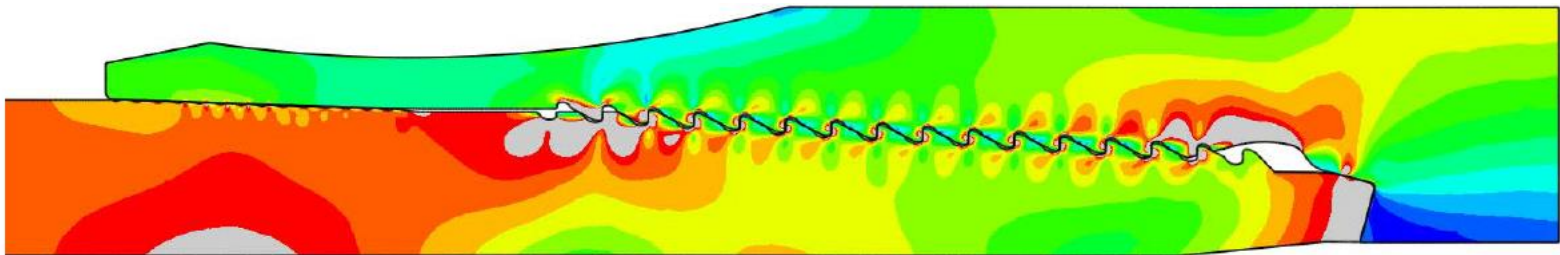
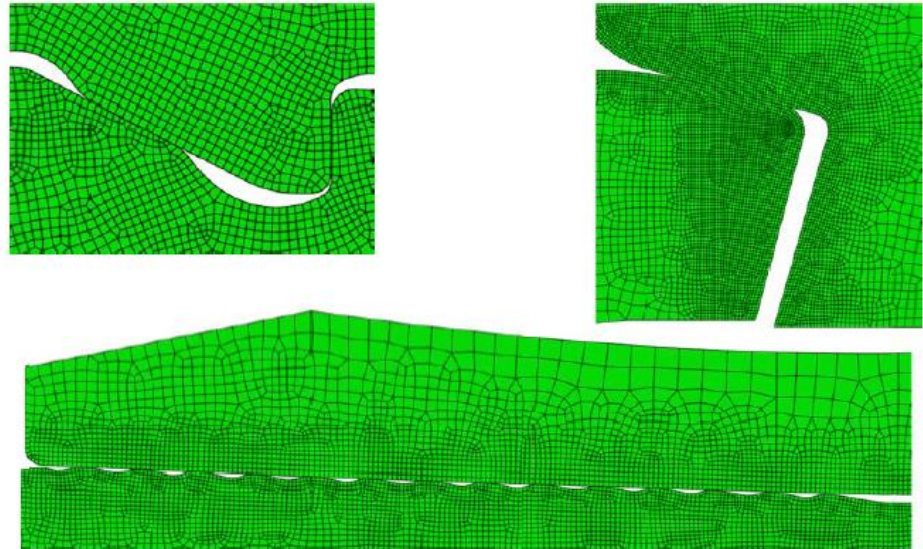


# Testing Results

# Design/Testing Results

- Finite Element Analysis Results (FEA)

- Detailed FEA work showed the connection/pipe met load performance required
- Results of the FEA were compared to previously tested connections to give more confidence in performance prior to testing
- Based on positive comparison the design was able to move into the testing phase



# Design/Testing Results

- Testing Results
  - Following design modifications during the FEA stage, the design was successfully tested
  - All specimens passed M&B, Sealability, and fatigue testing without issue

Sample	M&B Test	ISO Series B Test	ISO Series C Test	ISO Series A Test - Elevated	ISO Series A Test - 5xQ1-Q3	ISO Series A Test - Ambient	Failure
1 - R11005	Completed 03/09/2016 in VRCC	Completed 03/20/2016 in VRCC	Completed 04/22/2016 in VRCC	Completed 04/29/2016 in VRCC	Completed 05/03/2016 in VRCC	Completed 05/13/2016 in VRCC	Completed 05/13/2016 in VRCC

Sample	M&B Test	ISO Series B Test	ISO Series C Test	ISO Series A Test - Elevated	ISO Series A Test - 5xQ1-Q3	ISO Series A Test - Ambient	Survival bending	Failure
2 - U8301-02	Completed 06/16/2016 in VRCC	Completed 06/20/2016 in VRCC	Completed 07/01/2016 in VRCC	Completed 07/12/2016 in VRCC	Completed 07/13/2016 in VRCC	Completed 07/28/2016 in VRCC	Completed 07/28/2016 in VRCC	Completed 07/29/2016 in VRCC

Sample	1st Assembly	1st Hydrotest / Gas IP	5 M&B	2nd Hydrotest / Gas IP	5 M&B Round robin	3rd Hydrotest	5 M&B
3 - R11004	Completed 03/09/2016 in VRCC	Completed 03/09/2016 in VRCC	Completed 03/15/2016 in VRCC	Completed 03/16/2016 in VRCC	Completed 03/17/2016 in VRCC	Completed 03/22/2016 in VRCC	Completed 03/23/2016 in VRCC
		4th Hydrotest	5 M&B Round robin	5th Hydrotest	5 M&B	6th Hydrotest / Gas IP	Failure
		Completed 03/24/2016 in VRCC	Completed 03/24/2016 in VRCC	Completed 03/31/2016 in VRCC	Completed 04/04/2016 in VRCC	Completed 04/05/2016 in VRCC	Completed 04/06/2016 in VRCC

Sample	Assembly	Fatigue testing	IP post fatigue with gas	IP post fatigue with water	Break-out
4 - U8401	Completed 07/11/2016 in VRCC	requirement completed 08/05/2016 in VRCC	Not required		To be continued until failure
5 - U8402	Completed 07/11/2016 in VRCC	Completed until failure 09/12/2016 in VRCC			Completed 09/28/2016 in VRCC
6 - U8403	Completed 07/26/2016 in VRCC	requirement completed 09/21/2016 in VRCC			To be continued until failure
7 - U8406	Completed 06/23/2016 in VRCC	Completed 07/06/2016 in VRCC	Completed 07/22/2016 in VRCC	Completed 07/22/2016 in VRCC	Not required
8 - U8405	Completed 06/16/2016 in VRCC	Completed 06/22/2016 in VRCC	Completed 07/25/2016 in VRCC	Completed 07/26/2016 in VRCC	
9 - U8404	Completed 06/23/2016 in VRCC	Completed 06/30/2016 in VRCC	Completed 07/27/2016 in VRCC	Completed 07/27/2016 in VRCC	



# Design/Testing Results

- Make and Break Results
  - 25 M&B Cycles Completed without Galling



# Design/Testing Results

- Sealability Results
  - Combined Load tests completed without leak



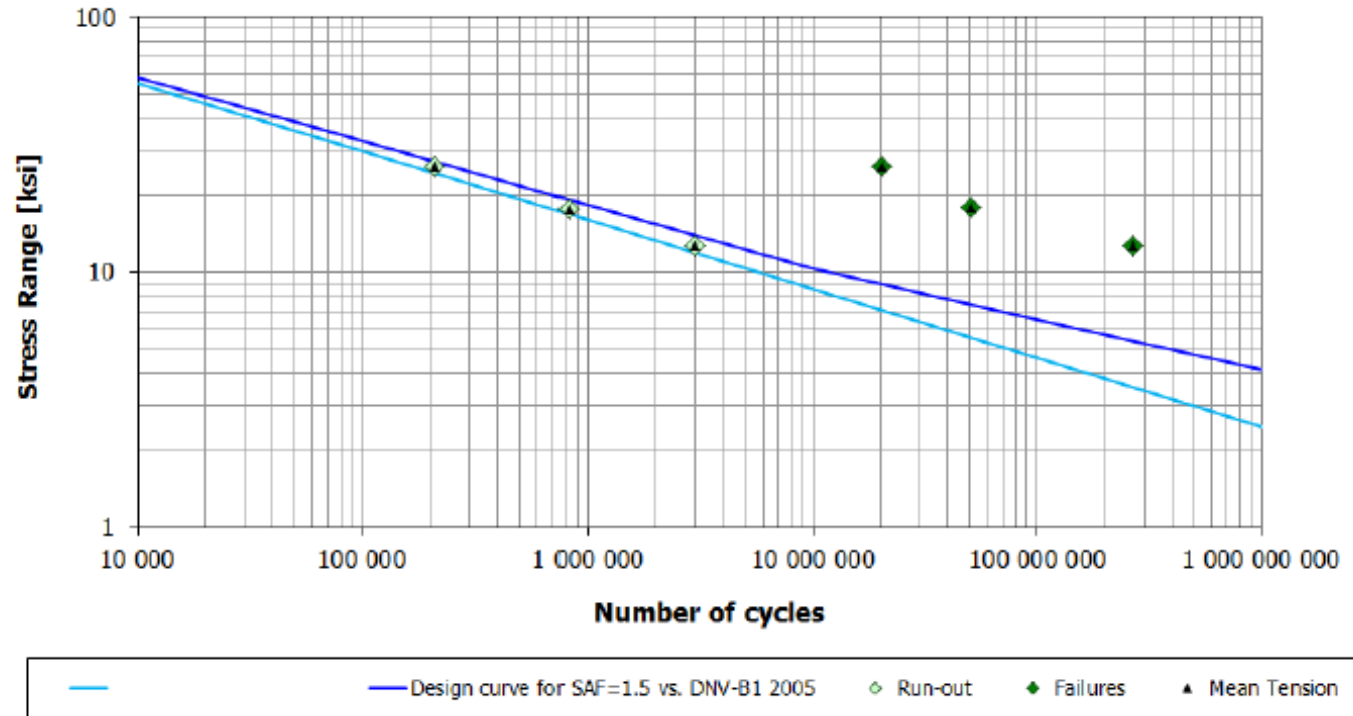


# Design/Testing Results

- Fatigue Results
  - High Cycles Achieved



7" 0.85" C110 VAM TTR S-N Data  
including Miner damage for subsequent loads





# Questions