

X-Mark Pro Trigger Pull Force
Audit

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XMP Audit – Background

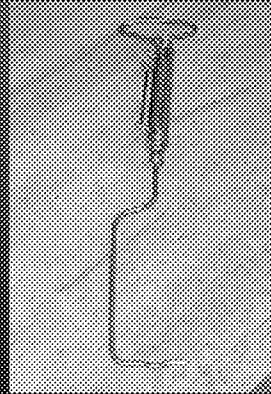
- Eight writers' rifles from a June hunt had higher than expected trigger pull forces
- Marketing measured trigger pull forces on 4 of the 8 guns above high limit (>5.5 lbs) after the hunt
- Marketing requested that production review the production trigger pull setting and verification process to understand why trigger pulls above high limit were found
- A warehouse audit of the trigger pull force on rifles with XMP trigger assemblies was requested by marketing at the August Product Team meeting

XMP Audit – The Task

- Measure trigger pull on a statistically valid sample of production rifles with XMP trigger assemblies
- Measure trigger pull using multiple measurement methods
- Analyze the data
- Report back on findings

XMP Audit – Equipment

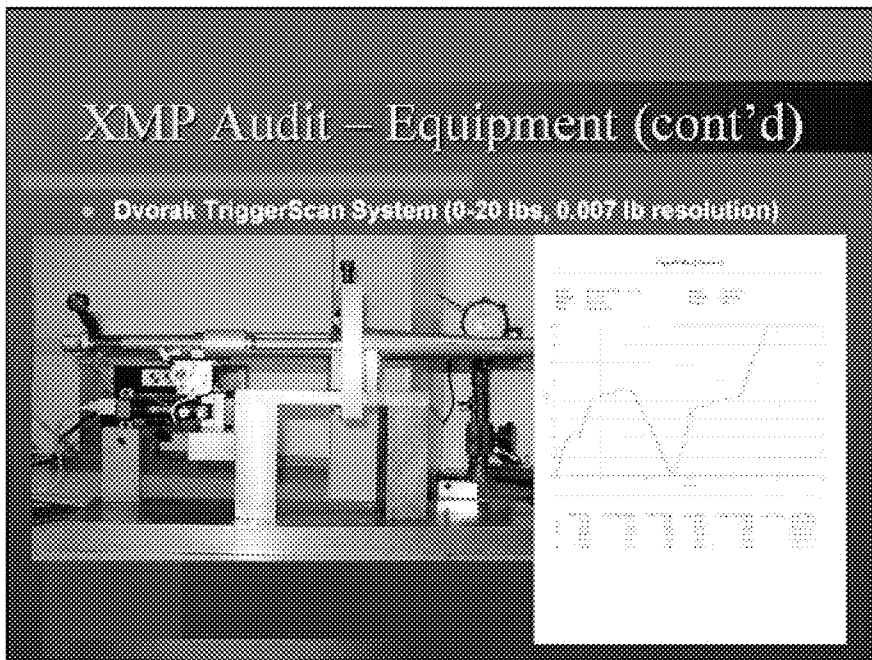
- Handheld Chatillon spring scale (0-10 lbs, ¼ lb resolution)



XMP Audit – Equipment (cont'd)

- Handheld Lyman digital trigger pull gage (0-12 lbs, 0.5 oz. resolution)





XMP Audit – The Procedure

- **Measure trigger pulls using the Chatillon gage**
 - 3 measurements – no cycling the safety (NSC) between trigger pulls
 - 3 measurements – cycling the safety (SC) between each pull
- **Measure trigger pulls using the Lyman gage**
 - 3 measurements – no cycling the safety (NSC) between trigger pulls
 - 3 measurements – cycling the safety (SC) between each pull
- **Remove the action from the stock**
- **Measure trigger pulls using the Dvorak**
 - 5 measurements – cycling the safety (CS) between each pull
 - 5 measurements – no cycling the safety (NSC) between trigger pulls
- **Reassemble the action to the stock, verify function**

XMP Audit – SKU Data

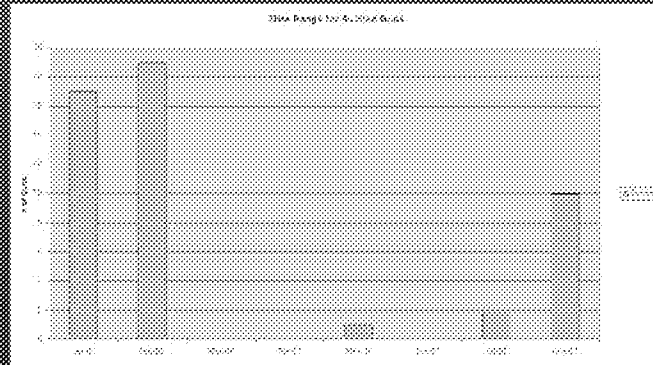
- A snapshot of bolt action centerfire rifle warehouse inventory on 6/30 served as the basis for SKUs selected
- 23 SKUs for test were selected proportionally to their warehouse inventory position
- Several SKUs from the original order required alternate selections as none of the available inventory had XMP trigger assemblies

SKU	Description	Qty	SKU	Description	Qty	SKU	Description	Qty
27063	700 COL	8	27047	700 COL	1	84012	700 COL SF	1
27239	700 SPS DM	7	27049	700 COL	1	84030	700 COL B&C	1
84171	700 SPS DM C	6	27062	700 ADL Syn Y Sc	1	84054	700 COL B&C	1
27235	700 SPS DM	6	27097	700 ADL Syn Sc	1	84055	700 COL B&C	1
27011	700 COL	2	27142	700 SPS SS DM C	1	84174	700 SPS DM C	1
27095	700 ADL Syn Sc	2	27143	700 SPS SS DM C	1	84262	700 Alaskan Tr	1
84081	700 COL B&C	2	27268	700 VSP	1	84276	700 Mini LSS	1
84217	700 SPS Var	2	27343	700 SPS DM *	1			

* non-XMP trigger assembly

XMP Audit – Data Analysis

- Production dates for audited sample range from 1/3/07 to 8/30/07



XMP Audit – Data Analysis

- Analysis of dataset done by Jim Snedeker
 - All six measurement sets passed tests for valid normal distributions
- Sample size for audit was 48 – gun #13 had old style trigger assembly even though box label was coded for XMP (production date was 2/3/97)
- Different methods of measurement yielded different mean and SD values
 - Chatillon sample mean ± 0.46 lbs lower than Dvorak SC
 - Lyman sample mean ± 0.38 lbs higher than Dvorak SD
 - Dvorak SC yielded lowest average SD for a given gun
 - Lyman HSC yielded highest average SD for a given gun
- Lyman data is suspect
 - Pull-to-pull variations of up to 2.38 lbs within a single test
 - Highest SDs within a single test of all methods used
- Apples-to-apples comparison of data for production method showed nothing over high limit and mean = 4.513 lbs
- Percentage of rifles that failed to meet trigger pull specifications varied from 8.2% to 22.4%, depending on the method chosen
- Regardless of measurement method chosen, the current process yields ± 2 lb range
- A new process is needed to yield tighter control on trigger pull force

XMP Audit – Data Analysis

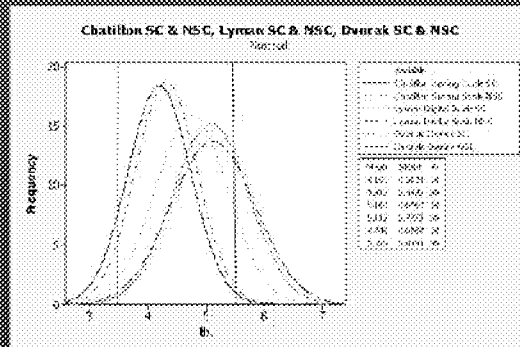
- Descriptive statistics for averages of measurements

Method	Mean	SD	Min	Max	Range
Chatillon SC	4.195	0.5424	3.000	5.167	2.167
Chatillon NSC	4.313	0.5328	3.167	5.800	2.333
Lyman SC	5.164	0.6768	3.771	6.833	3.062
Lyman NSC	5.117	0.7270	3.354	6.917	3.563
Dvorak SC	4.749	0.6289	3.415	5.947	2.532
Dvorak NSC	5.079	0.6554	3.562	6.456	2.894

* Table includes data for gun #12 – not XMP trigger assembly

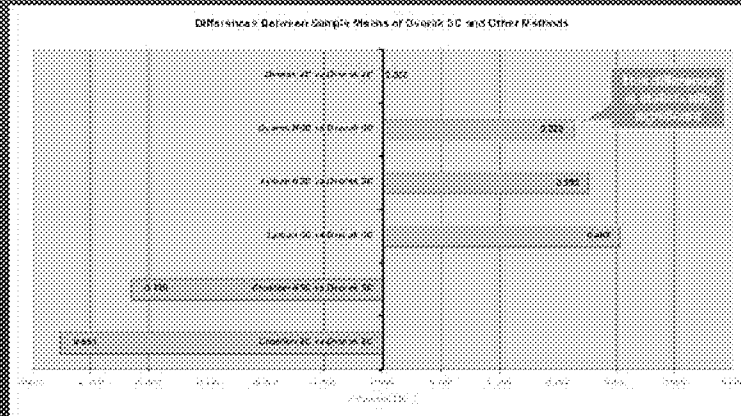
XMP Audit – Data Analysis

- Comparison of distribution of averages of measurements by method

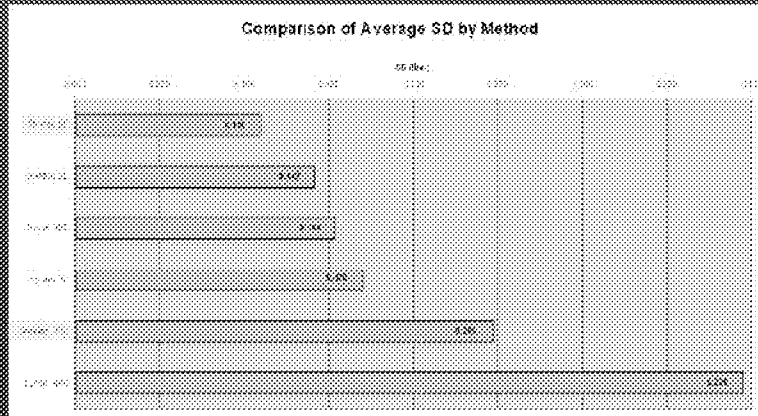


* Distributions includes data for gun #12 - no XMP trigger assembly

XMP Audit – Data Analysis



XMP Audit – Data Analysis



XMP Audit – Data Analysis

• Comparison of Nonconformity Found By Each Method

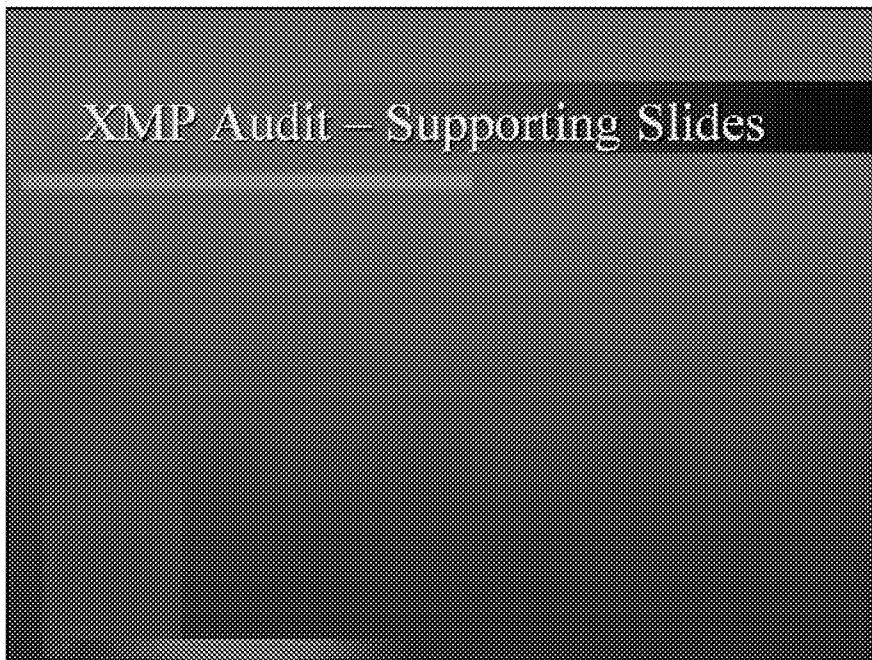
Method	# < LSL	# > USL	# OUT	% nonconforming
Challin SC	4	0	4	8.2%
Challin NSC	4	0	4	8.7%
Lyman SC	0	11	11	22.4%
Lyman NSC	1	9	10	20.4%
Dvorsk SC	2	0	2	10.3%
Dvorsk NSC	0	10	10	20.4%

XMP Audit – General Observations

- Some trigger assemblies show more pull-to-pull variation than others
 - Variation seemed to be independent of measurement method
 - Source of the variation is unknown
- Chatillon spring scale measured trigger pull ~0.49 lb lower than Dvorak SC
- Lyman digital force gage measured trigger pull ~0.38 higher than Dvorak SC
- Dvorak SC yielded lowest average pull-to-pull SD
- Lyman NSC yielded highest average pull-to-pull SD

XMP Audit - Recommendations

- Need a new trigger pull setting and measuring process
- The new process should:
 - Provide better resolution of the measurement than current method
 - Provide a tighter setting range (if possible)
 - Remove the effects of the operator on the measurement wherever possible
 - Minimize impact on product cost while maximizing productivity
 - Provide information on trigger pull other than just peak force



XMP Audit – Data Analysis

• Comparison of Standard Deviations for Each Method

← Increasing SD

Comparison of Method SD - ALL	Avg.	SD	MAX	MIN	Range
Dental SC	3.146	0.073	0.307	0.011	0.295
Charles SC	3.163	0.121	0.722	0.009	0.722
Dental NSC	0.164	0.005	0.474	0.017	0.457
Lyman SC	0.170	0.090	0.307	0.000	0.307
Charles NSC	3.240	0.148	0.801	0.009	0.801
Lyman NSC	3.395	0.333	1.204	0.000	1.204

XMP Audit – Data Analysis

• Comparison of Standard Deviations for Each Method

One-way ANOVA: Charillon SC, Charillon SSC, Lyman SC, Lyman SSC, Densak SC, & Densak SSC

Source	DF	SS	MS	F	P
Factor	5	45.537	9.107	22.88	0.000
Error	284	117.134	0.416		
Total	289	162.671			

S = 0.6442 R-Sq = 28.61% R-Sq (adj) = 26.77%

Individual 95% CIs for Means Based on Pooled StDev



Pooled StDev = 0.6442

Note: There is statistically significant difference between the Densak SC and the Densak SSC methods (in red above.)

