SPACE SHUTTLE
Solid Rocket Motors
Thiokol Corporation

TWR-60119, Rev A

TETHERING SOCKETS AND WRENCHES

FINAL REPORT

JULY 1990

Prepared for:

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
GEORGE C. MARSHALL SPACE FLIGHT CENTER
MARSHALL SPACE FLIGHT CENTER, ALABAMA 35812

Contract No. NAS8-30490

DR. No. ~~5-3~~ 3-5

WBS.No. 4B 201

Thiokol CORPORATION
SPACE OPERATIONS

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

(NASA-CR-184032) TETHERING SOCKETS AND WRENCHES Final Report (Thiokol Corp.) 12 p CSCL 14B
N91-13675
Unclas
G3/35 0309736

FORM TC 4677 (REV 1-88)

DOC NO. VOL REV

TITLE

TWR-60119 REV A

PEI-994

TETHERING SOCKETS AND WRENCHES

FINAL REPORT

JULY 1990

PREPARED BY:

E. P. JOHNSON
MIX AND CAST
M&P PRODUCTION SUPPORT

APPROVED BY:

G. W. Dixon
SRM Program Management

R. A. Guthrie
Industrial Safety

B. Hutchinson
Design Engineering

9/5/90

SR&QA

J. H. Stoker
Systems Integration Engineering

Thiokol CORPORATION
SPACE OPERATIONS

P.O. Box 707, Brigham City, UT 84302-0707 (801) 863-3511

9-6-90

Release, Data Management
ECS NO. SS 3857

ACTIVE PAGE RECORD

PAGE NO.	REVISION	PAGE NO.	REVISION	PAGE NO.	REVISION	PAGE NO.	REVISION
i	N/A						
1	N/A						
2	A						
3	N/A						
4	N/A						
5	N/A						
6	N/A						
7	N/A						
8	N/A						

REVISION DESCRIPTION

REV LTR	DATE	DESCRIPTION
A	6/1/90	One additional recommendation was made to not tether the crows foot wrenches to the ratchets. The reasoning being that the segment case is completely covered when the crows foot wrenches are used. (Recommendation #2)

CONTENTS

Reference: Waldes Truarc Retaining Rings Technical Manual

Process Engineering Technical Report Categories

Casting
Machining
Tooling

1.0 INTRODUCTION

On 11 November 1989 while tooling was being assembled over a casting pit to make ready for a cast, a socket was dropped into the unloaded motor. To retrieve the socket, it was necessary to disassemble the tooling. In answer to the discrepancy report (DR 157941), all sockets that are to be used to assemble tooling over the case will be tethered to the ratchets that are tethered to the operator's hand.

To accomplish the tethering of the sockets to the ratchets, a special design was implemented in which a groove was machined into each socket. Each socket was then fitted with a snap ring that can spin around the machined groove. The snap ring is tethered to the handle of the ratchet (Figure 1). All open end wrenches are also tethered to the ratchet or to the operator, depending upon the type (Figure 2). Tests were run to ensure that the modified tools meet torque requirements. The design was subsequently approved by Space Safety. The modified tools have been placed on the applicable casting pits'shadow boards.

2.0 OBJECTIVE

To provide the casting pit personnel with a method to tether the sockets and wrenches to the ratchets.

3.0 CONCLUSIONS

1. The test results of the tethered sockets and wrenches to the ratchets verify that the modified sockets still meet the torque.

2. The tools were reviewed by Space Safety and approved to be used on the production line.

3. The design of machining a groove in the sockets so that a snap ring would fit around the socket, but still be secured to the socket, has proven to be a good method of tethering the socket to the ratchet. The design is a simple answer to the problem, but also an effective one. A more feasible answer to the problem could possibly be found, but to quickly improve the safety of using tools over the motor segments, this design was adopted and does meet all the safety requirements to facilitate continued use of sockets and ratchets around the casting pits.

4. All of the test socket sets were tested to torque loads that equal or exceed three times the loads that are called out in the manufacturing planning. The sockets were then inspected for any cracks or flaking that might have resulted due to the tests. For example, the planning calls out for the bolts to be torqued to 75 ft-lb. The sockets were then repeatedly tested to 225 ft-lb. The manufacturer (Snap-On) rates this same socket at a maximum load of 285 ft-lb of torque. A sampling of the modified sockets that were to go on to the production floor were tested in this same manner.

5. After machining and testing the various sockets, the differences between the quality of the various manufacturer's tools was obvious. Snap-On manufactured sockets have a much thicker side wall and four indentations for locking purposes (one per side). Some of the other manufacturers have only one indentation that is used to lock the socket to the ratchet. This means that the user has one chance in 4 to lock the socket to the ratchet. With Snap-On sockets and ratchets, there is a much better fit than with any of the other tools that are used in the casting pit areas.

4.0 RECOMMENDATIONS

The tethering of sockets and wrenches was accomplished to improve the safety of working over motor segments and to answer the discrepancy report. After meeting these two goals with the new tethered sockets, the following recommendations are made:

1. The snap hook that is used to connect the ratchet tether to the snap rings is not the ideal hook for the job. The hook is hard for an operator to manipulate and a better locking hook should be used if it can be found. After meeting with Snap-On Tool supplies and discussing the design, it was decided to eliminate the snap from the design. In place of the snap hook, a loop will be built into the tether line that will just barely slip over the handle end of the ratchet (refer to Figure 1).

* 2. After consulting with the supervision over the casting area it was decided that the crows foot wrenches are only used after the segment case is covered completely therefore there is no need to tether these wrenches to the ratchets. The method of tethering the crows foot wrenches (Figure 2) makes the wrenches awkward to use properly. It is recommended that the crows foot wrench not be tethered.

3. Several tool vendors make socket sets that have locking features built right into the ratchet, such as Snap-On's pushbutton set. This type of locking feature secures sockets to the ratchet and eliminates the external tethering lines. These types of tools are also more convenient for the operators to use than the tethering of sockets to their ratchets. As new tools are needed, tools should be purchased with built-in locking devices.

4. The socket sets that are used at the casting pits are made by various vendors. The overall quality of the various vendor's tools differ from fitting tolerances to material quality. If the sockets are going to continue to be machined, it is recommended that the best quality tools be used. Out of the various suppliers of tools to be used at the casting pits, Snap-On has the best overall quality.

5.0 DISCUSSION AND RESULTS

This tethering design was in answer to a discrepancy report (DR 157941) that was issued when a socket was accidentally dropped into an unloaded SRM segment during assembly operations. The method of tethering the sockets needed to be accomplished as quickly as possible to get the tools back into the hands of the operators.

5.1 Results Of The Project

A method was designed in which a socket-type tool could be tethered to a ratchet (Figures 1 and 2). This design requires that each socket have a groove machined into the socket's circumference. The groove is to be machined into the thickest portion of the socket and machined according to Table I. Table I also identifies the size of the basic external snap ring to be used for each size of socket that is currently used in the casting pit area.

An initial set of tools was machined and tested to determine if the design was feasible and if the sockets were still safe to use after the modifications were complete. All Snap-On 1/2-in. drive sockets are rated to 285 ft-lb. Our planning requires that the sockets be exposed to 75 ft-lb of torque. Each tool in the initial set and a sampling of all the other tool sets were tested to determine if they could safely meet all the required torque loads that they would be exposed to. To test these tools, they were exposed to repeated loads that equaled or exceeded three times the planning's load requirements. For example, all sockets that receive a 75 ft-lb load on the production line were tested at 225 ft-lb.

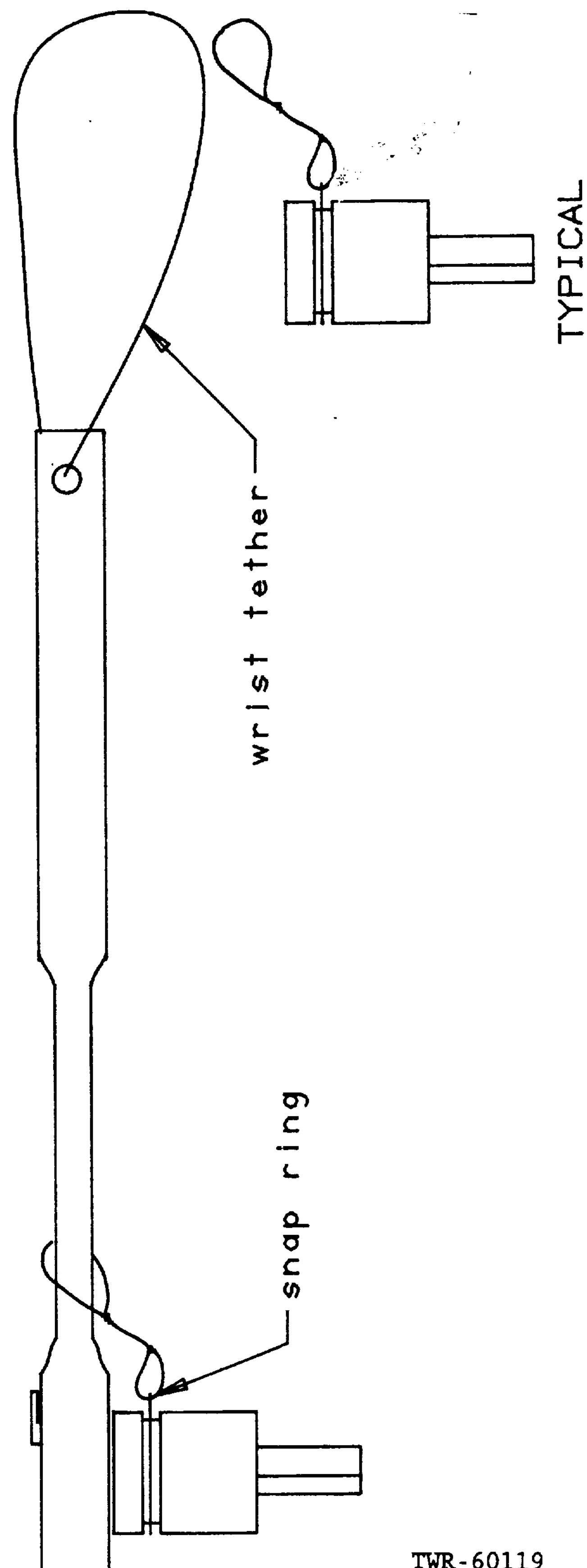

Figure 1. Socket Tethered To Ratchet

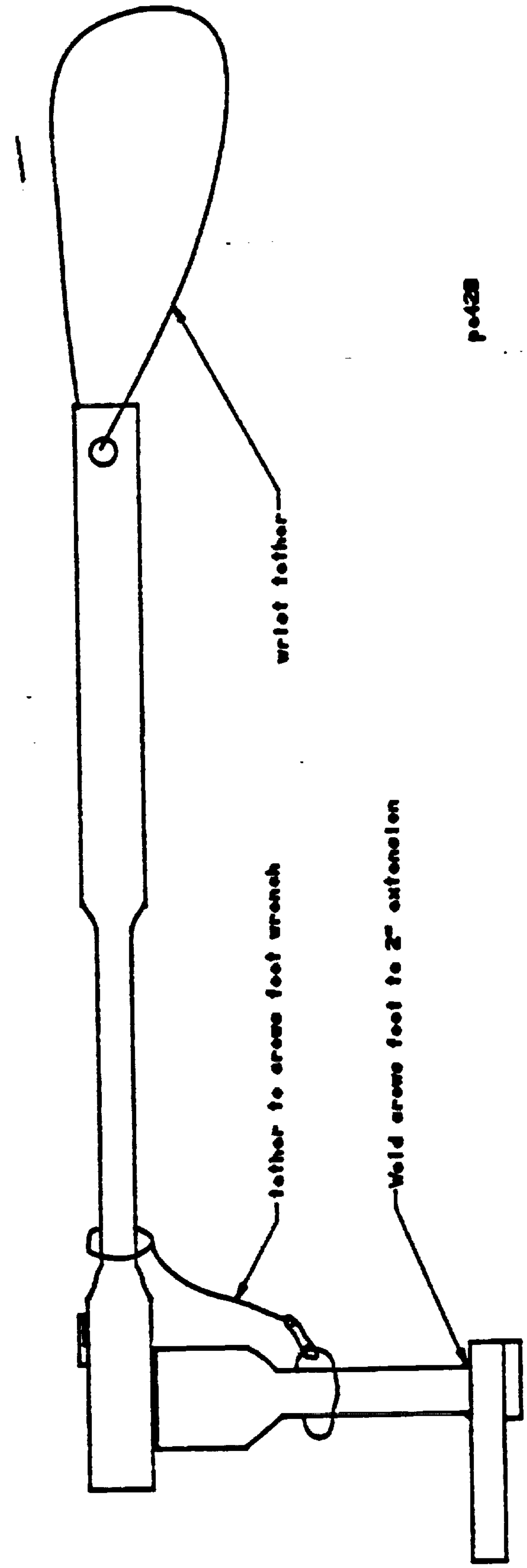

Figure 2. Crow Foot Wrench Tethered To Ratchet

TABLE I. Machining Chart

SOCKET SIZE	TYPE	ORIGINAL DIA.	MACHINED DIA.	RING ID	SNAP RING
ALLEN HEADS:					
3/4*	SN	1.388	1.354	1.387	5100-150
5/8* @	SN	1.153	1.104	1.156	5100-125
5/8	PR	1.100	1.000	1.041	5100-112
9/16* @	SN	.974	.942	.982	5100-102
1/2*	SN	.965	.940	.946	5100-102
7/16*	SN	.946	.938	.946	5100-102
3/8* @@	SN	.882	.835	.867	5100-93
5/16*	SN	.890	.835	.867	5100-87
DEEP WELL SOCKETS:					
7/8 @	SN	1.078	1.000	1.041	5100-112
1/2 @@	SN	.896	.818	.810	5100-87

* used on casting pits
@ used in casting house
SN= Snap-On
PR= Proto

NOTE

MACHINE THE GROOVE INTO THE SECOND MANUFACTURED GROOVE ON ALL ALLEN HEAD SOCKETS. MACHINE THE GROOVE DOWN INTO THE BODY OF THE SOCKET FOR ALL DEEP WELL SOCKETS WHERE THE SOCKET WALL IS THE THICKEST.

THE SNAP RINGS HAVE TO FIT GOOD INTO THE MACHINED GROVE, BUT STILL BE ABLE TO EASILY SPIN AROUND.

REFER TO THE WALDES TRUARC RETAINING RING TECHNICAL MANUAL