Good Practice Guide

Installation of Valves and Plugs in UF6 Cylinders

Revision: 1
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Objective

This industry good practice guide provides valuable information to achieve successful installation of 1" valves and 1" and 1.5" plugs in new as well as in-service UF6 cylinders, based on ANSI N14.1-2019 and ISO 7195-2020.

This guide replaces the WNTI Good practice guide for installation socket head plugs in UF6 cylinders.

Note: Readers shall refer to the applicable version of the standards

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Background Information

For decades, the industry has successfully used, and continues to use, so-called, hex head plugs (1'' and 1.5'') and valves (1'', type 51) in 30'' and 48'' UF6 cylinders. Socket head plugs were first introduced through an addendum to the 2001 Edition of ANSI N14.1.

The design of the socket head plug is specified in ANSI N14.1 and ISO 7195 and now available for use as an alternate for the hex head plug.

Industry experience has shown that the installation process for valves and socket head plugs requires inspection and preparation of cylinder couplings, as well as proper selection of valves and plugs (size/tinning). The use of tight fitting tools and controlled torqueing is also essential.

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Cylinder Coupling Inspection

3.1 General

The cylinder coupling requirements are specified in ANSI N14.1 and ISO 7195. Plug couplings can have a 1" or 1.5" NPT thread size. Valve couplings have only 1" NPT thread size.

3.2 New cylinders

The following only applies to newly fabricated cylinders.

Before installation of a valve or plug into a cylinder, the coupling shall be cleaned with an appropriate NPT tap (see Figure 1) to remove residues of impurities. The tap shall be screwed into the coupling, by hand, until it blocks (see Figure 2). Taking care, a wrench may be used to facilitate the insertion of the tap.

After welding the threads of new couplings shall be in accordance with the thread standard ANSI/ASME B1.20.1. Therefore couplings must be carefully welded into the cylinder head plates to avoid deformation due to excessive heat input.

After welding, the coupling shall be cleaned with an appropriate NPT tap (see Figure 1) to remove impurities. The tap shall be screwed into the coupling, by hand, until it blocks (see Figure 2). Taking care, a wrench may be used to facilitate the insertion of the tap. The tap used shall not have broken teeth or other damages.

Following removal of the tap, the coupling threads shall be cleaned and shall be visually inspected. No broken/damaged threads shall be seen and the threads shall be clean.

Note: A well cleaned coupling is also necessary for good gauging.

The coupling threads shall then be checked with an appropriate NPT gauge (Figure 3 and 4 show examples). The gauging shall confirm compliance with ANSI/ASME B1.20.1.

A too small or too large coupling and/or broken/damaged threads shall be reason for rejection.

The aforementioned inspection steps may have to be repeated prior to valve or plug installation.

3.3 In-service cylinders

The following only applies to in-service cylinders which have been cleaned and washed out.

Before installation of a valve or plug into a cylinder, the coupling shall be cleaned with an appropriate NPT tap (see Figure 1) to remove residues of tin and other impurities. The tap shall be screwed into the coupling, by hand, until it blocks (see Figure 2). Taking care, a wrench may be used to facilitate the insertion of the tap.

Following removal of the tap, the coupling threads shall be cleaned (e.g. brush, pin or vacuum cleaner) and shall be visually inspected for missing or damaged threads. Acceptance criteria are:

- No more than 10mm of thread damage at one spot, or.
- No more than 15mm cumulative throughout the couplings thread length.

Note: A well cleaned coupling is also necessary for good gauging.

As a next step, it is recommended to check the threads with an appropriate NPT gauge (Figure 3 and 4 show examples) to determine the approximate coupling size (small / nominal / large). Gauging according to ANSI/ASME B1.20.1 is not required. But a too large coupling may be reason for rejection. Suggested rejection criterion is:

- More than nominal +2.0 threads.

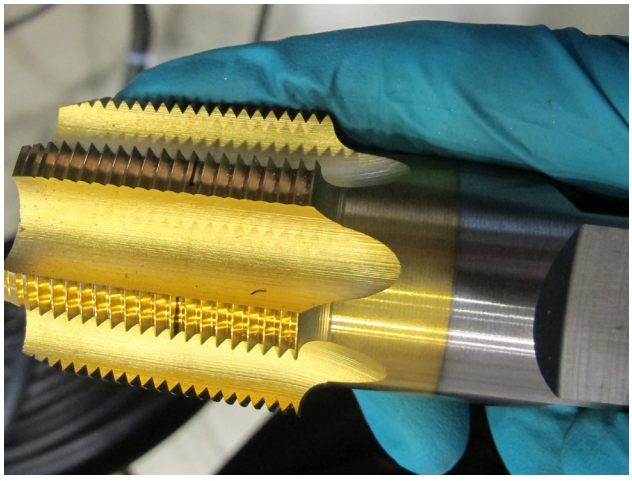


Figure 1: Example of a NPT tap

Figure 3: Example of a standard NPT gauge

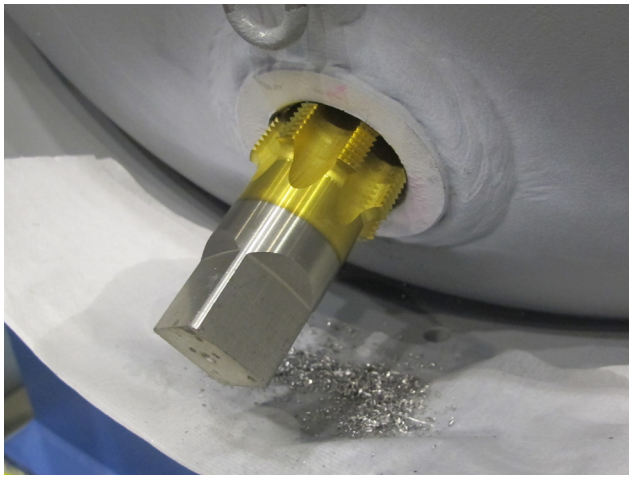


Figure 2: Tap inserted into a cylinder coupling (paper has been moistened with alcohol to attract loose particles, but this is not required)

Figure 4: NPT gauge inserted into a cylinder coupling

Caution!!

- No cutting fluid or lubricant shall be used to facilitate the insertion of the tap or gauge!
- The gauge shall be lightly inserted into the coupling “without the use of force”!

04

Plugs and Valves

4.1 General

1” and 1.5” hex head and socket head plugs and 1” valve (type 51) 1” and 1.5” hex head and socket head plugs and 1” valve (type 51) are specified in ANSI N14.1 and ISO 7195.

Only new valves and plugs shall be used for installation, reuse or re-tinning is not allowed.

4.2 Thread sizing

The size of the valve or plug threads and the E0 diameter (start diameter of the taper thread) are specified in ANSI/ASME B1.20.1.

For socket head plugs the E0 diameter is located 0.400” below the top face of the 1” plug and 0.420” below the top face of the 1-1/2” plug.

For hex head plugs the E0 diameter is located at the bottom face of the plug.

For valves, the E0 diameter is located approximately 0.174” from the bottom face of the valve. Taper threads to be measured with a standard NPT gauge (see Figure 5 for an example of a standard NPT gauge).

Standard ranges for un-tinned taper threads:

The ANSI N14.1 and ISO 7195 standards allow the (un-tinned) taper thread to be:

For socket head plugs:
1) Max. size (nominal), or
2) Min. size (1 turn small).

For hex head plugs:
1) Basic size (nominal),
2) Max. size (1 turn large), or
3) Min. size (1 turn small).

For valves (type 51):
1) Max. size (nominal minus 1.5 turn),
2) Min. size (nominal minus 2.5 turn).

Figure 5: Example of a standard NPT gauge

Note: The size of the valve or plug, relative to the size of the coupling, influences the installation torque. It is recommended for the purchaser to specify small thread sizes but within the ranges of the standards.

4.3 Thread tinning

In accordance with ANSI N14.1 and ISO 7195 the thread roots of valves and plugs shall be filled at least half full with a uniform coating of tin unless otherwise specified by the purchaser.

To ease insertion and initial positioning of the valve or plug it is allowed to remove the tin from approximately the first two threads using a proper die.

Notes: It is recommended for the purchaser to specify the thread roots to be approximately filled half full with a uniform coating of tin and to remove the tin from approximately the first two threads, to facilitate the correct installation of valves and plugs.

Valves and plugs to be installed into in-service cylinders may require more tin to be removed from the first few threads (but not more than four) to facilitate the insertion, as couplings of in-service cylinders always contain a residue of tin even after cleaning the threads with an appropriate NPT tap.

4.4 Thread insertion and installation torque settings

Table 1 gives a summary of valve and plug thread insertion and torque settings.

TABLE 1

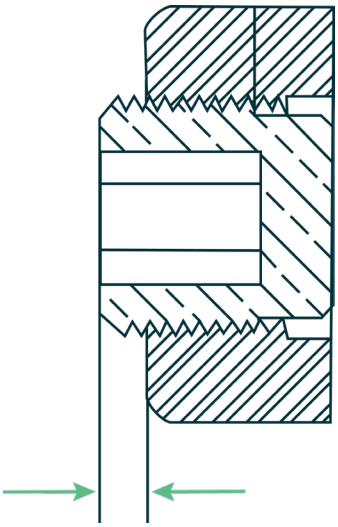
ITEMS	MIN. THREAD INSERTION	MAX. THREAD INSERTION	MIN. TORQUE (3) (LB-FT)	MAX. TORQUE (LB-FT)	MIN TORQUE (3) (NM)	MAX. TORQUE (NM)
1" (51) Cylinder Valve (1)	7	At least one thread showing	200 279 (2)	400	271 380 (2)	542
1" Hex Head Plug (1)	5	At least one thread showing	150 369 (2)	650	203 500 (2)	880
1.5" Hex Head Plug (1)	5	At least one thread showing	200 885 (2)	1330	271 1200 (2)	1803
1" Socket Head Plug (1)	3 above coupling (6.6mm) (see Fig. 6)	2 under coupling (4.4mm) (see Fig. 7)	150 369 (2)	650	203 500 (2)	880
1.5" Socket Head Plug (1)	3 above coupling (6.6mm) (see Fig. 6)	2 under coupling (4.4mm) (see Fig.7)	200 885 (2)	1330	271 1200 (2)	1803

(1) No material of any kind, other than the specified tin, shall be used on the threads to facilitate installation

.

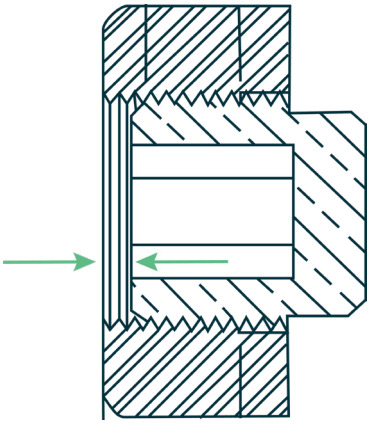
(2) ANSI / ISO requires lower settings, but to minimize the chance of leakage, higher torque settings are recommended.

(3) Where tooling is used that can result in a loss of applied torque, the set point value should be increased to compensate for losses.



3 threads (6.6mm) above flush

Figure 6: Minimum threads insertion for SHP



2 threads (4.4mm) below flush

Figure 7: Maximum threads insertion for SHP

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Tooling

5.1 Torque wrench / device

In accordance with ANSI N14.1 and ISO 7195 an adjustable or indicating torque measuring wrench / device shall be used for all operations. The use of an impact type wrench / device is not permitted. Recommended tooling are in Appendix 3.

Operational experience has shown that the use of a torque device in combination with a double reaction torque arm and a torque reaction hanging bracket improves the installation of valve and plug (see Figures 8, 9, 10 and 11).

Notes: A manual torque wrench may always be used, for example in case of a 1" valve or 1" plug installation. For installation of 1.5'' plugs, considering the high torque needed, the use of a torque device (electric, pneumatic or hydraulic) is recommended.

Figure 8: Example of a torque device with a double reaction arm

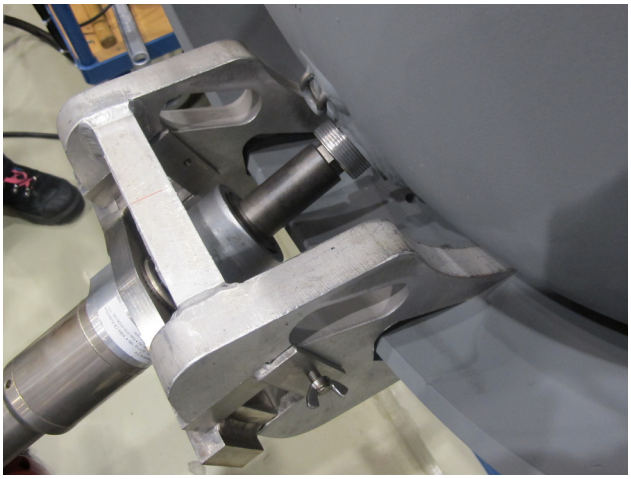


Figure 10: Example of a torque reaction bracket between the tool and the skirt

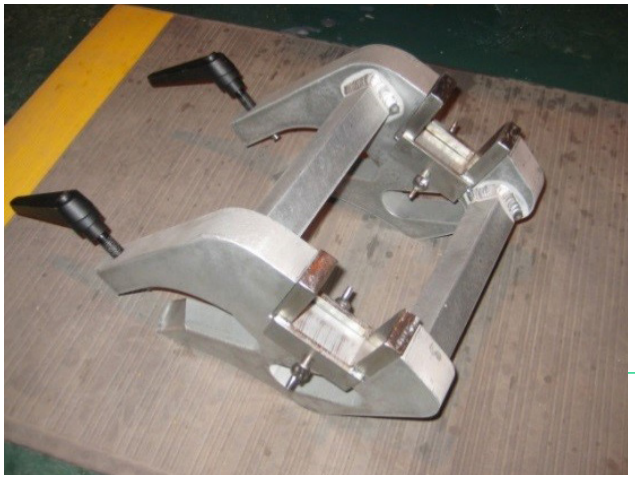


Figure 9: Example of a torque reaction hanging bracket

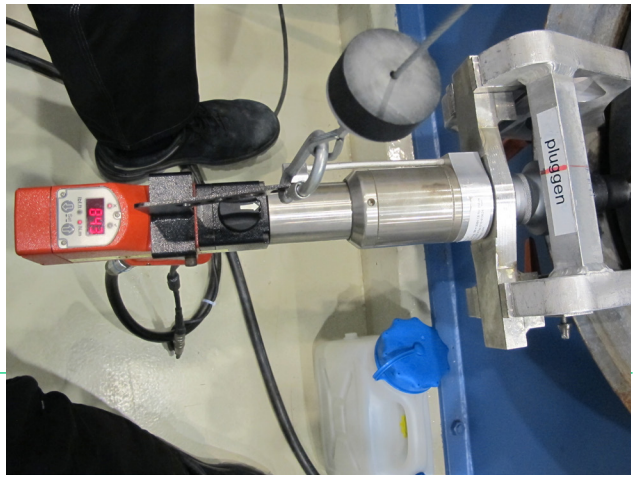


Figure 11: Example of a torque reaction hanging bracket (general view)

5.2 Tool bits, plug sockets and special tools for valve and plug installation

5.2.1 Tool bits and plug sockets for socket head plugs

The dimensions of the sockets of the 1” and 1.5” socket head plugs are specified in ANSI N14.1 Figure 17 part c and d, and in ISO 7195 figure 16 part c and d. The 1” plug has a 5/8” socket and the 1.5” plug has a 1” socket.

The dimensions of the 5/8” and 1” sockets and the tool bits are specified in ASME B18.3 Table 6 Dimension J for plug sockets and Table 8 Dimension W for tool bits.

Operational experience has shown that the tolerances for the dimensions of the tool bits and plug sockets in table 6 and 8 do overlap each other. The generous manufacturing tolerance for the 1” socket (from the ASME B18.1) can cause distortion of the socket during the installation process (see Appendix 1). Therefore it is recommended to order the 1” and 1.5” socket head plugs according to Table 2 of this guide.

Note: At the time of writing this paper the tolerances from Table 2 have been incorporated in the new revision of ISO 7195. Proposals to update ANSI N14.1 will follow in due course. It is recommended for the purchaser to specify the socket dimensions to the manufacturer at the time of ordering plugs.

The depth of the socket of the 1” and 1.5” socket head plugs is specified in ANSI N14.1 and ISO 7195 as Min 0.84” (21.3mm) / Max 0.87” (22.1mm).

Operational experience has shown that due to the high torques the socket can deform, or in the worst case, crack during the installation process (see Appendix 1). The root cause for this failure is that the length of the tool bit was too short or that the tool bit was not fully inserted or a wrong alignment during the installation process. Therefore the length of the tool bit always has to be more than 0.87” (22.1mm) and the tool bit has to stay fully inserted and well aligned during installation of the plug.

Note: The bottom face of tool bits should be flat (without rounded edges) to ensure full contact with the bearing faces in the socket (see Figure 12).

TABLE 2: RECOMMENDED DIMENSIONS OF 5/8” AND 1” PLUG SOCKETS

DIAMETER 5/8” SOCKET (1” PLUG)		DIAMETER 1” SOCKET (1.5” PLUG)	
Minimum mm (inch)	Maximum mm (inch)	Minimum mm (inch)	Maximum mm (inch)
15.900 (0.626)	16.000 (0.630)	25.450 (1.002)	25.600 (1.008)

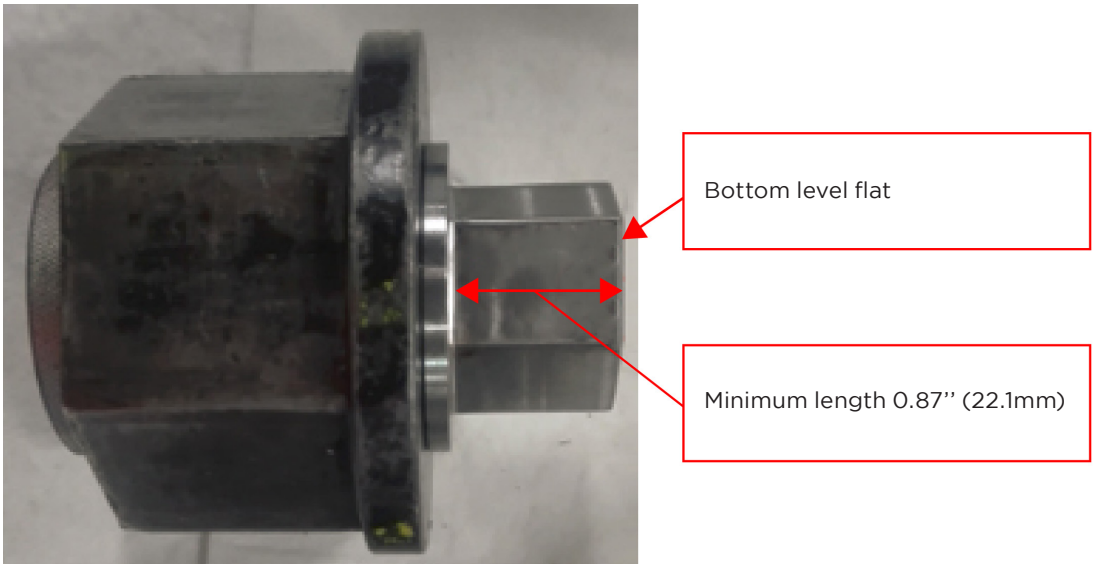


Figure 12: Example of a tool bit for socket head plugs

Appendix 2 Gives some recommendations regarding the quality of tool bits.

5.2.2 Tool sockets for hex head plugs

Standard hardened socket tools are available on the market:

- 1.5'' hex head plugs: 2''
- 1'' hex head plugs: 1.5''

5.2.3 Special tools for valves

Operational experience has shown that the valve body could be damaged during the installation of the valve and it could also be deformed so that the torque cannot be fully transferred to the threads. Slight deformation of the valve body is acceptable.

To limit any deformation of the valve body and to transmit the torque properly, the following is recommended:

- fully cover the body of the valve with a special tool (see Figures 13, 14 and 15),
- limit the clearance between the special tool and the valve body,
- protect the valve body from the tool using pieces of TEFLON or copper, for example.

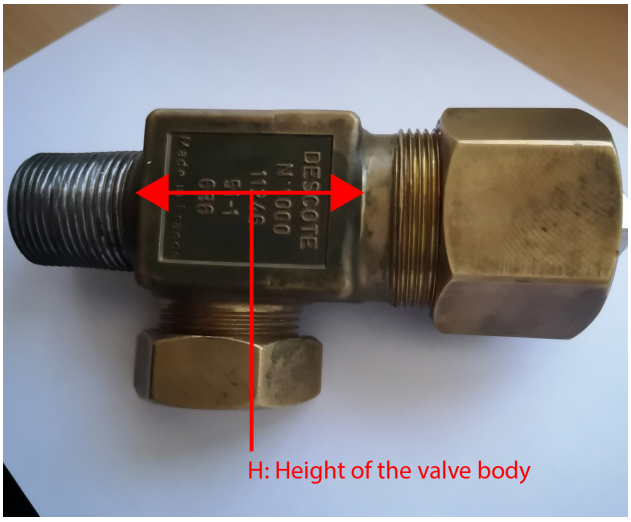


Figure 13: Example 1" valve type 51

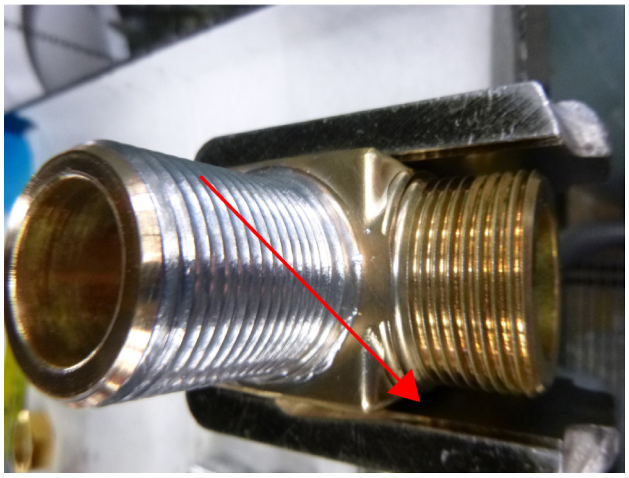


Figure 14: Example of a special tool to fully cover the valve body with minimum clearance between the valve body and the tool (see red arrow)

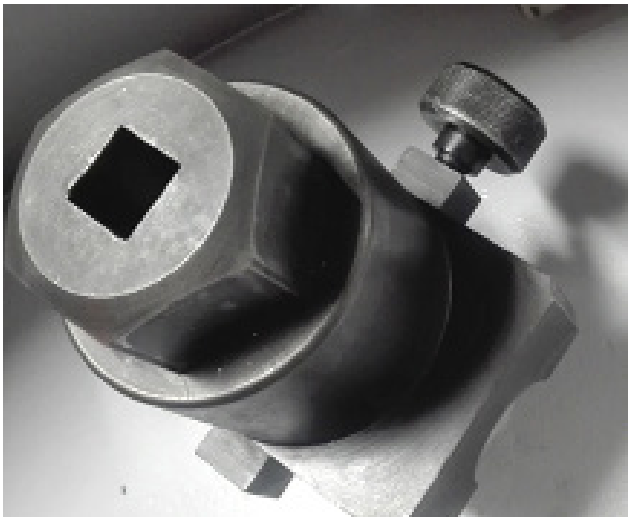


Figure 15: Example of a complete assembled special adapter for the valve

Positioning of the valve outlet (6 o'clock) must also be taken into account to allow good connection in plants.

Note: It is recommended to use a special tool to facilitate the correct installation of the valve (see Figure 16).

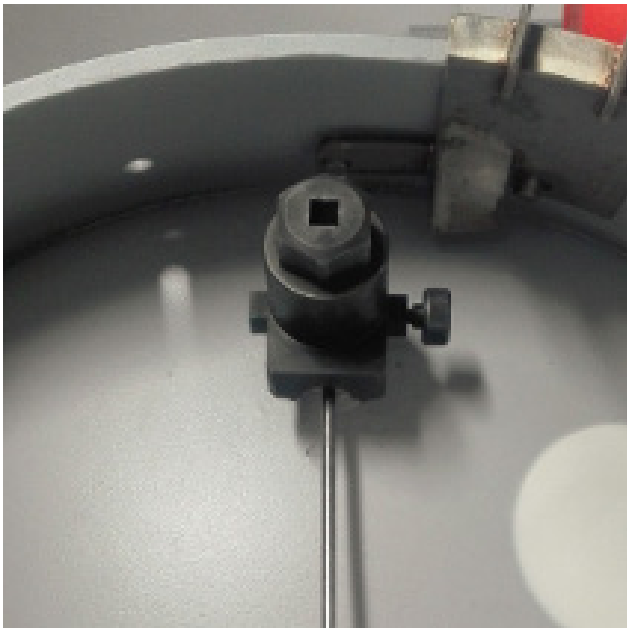


Figure 16: Example of a special tool for positioning valve, the pin is installed in the outlet port of the valve

5.2.4 Gauge design

5.2.4.1 Gauge design for hex head plugs

To design a gauge, the manufacturer of hex head plugs shall engrave on the upper surface of the plug the minimum value of its overall dimension (named A) in millimeters.

Note: It is recommended for the purchaser to specify this minimum overall dimension for the manufacturer at the time of ordering plugs (see Figure 17).

Example calculation for dimension of gauge:
When the overall dimension of a plug A=45.7 mm and the minimum threads to be inserted are 5, the maximum dimension of the gauge to be calculated as:

45.7(mm)-5 (threads) x 2.209 (mm/thread)=34.655 mm (≈ 34.7mm)

Thus, the dimension for the gauge shall be:
34.7 $^{0}_{-0.1}$ **mm**

Note: It is recommended to use a gauge (see Figure 17 green item for an example) to confirm the minimum thread insertion of hex head plugs

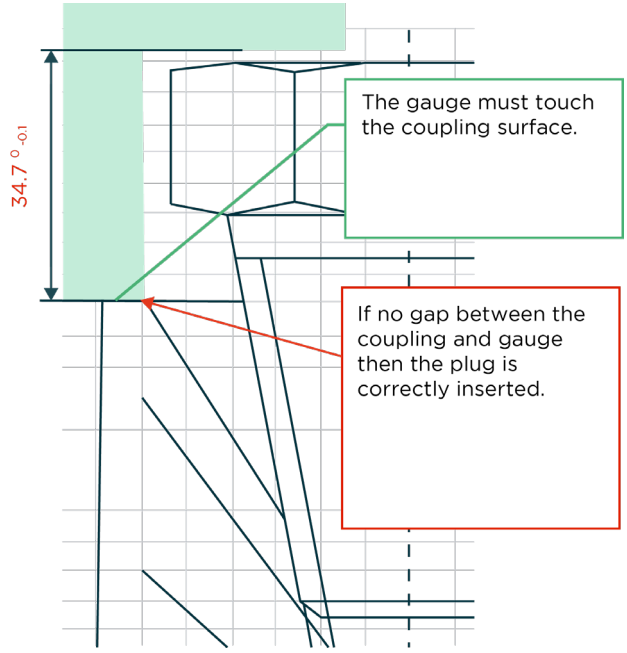


Figure 17: Example of a minimum installation gauge for hex head plugs

There is very small chance that a plug can reach the maximum threads insertion (at least one thread showing), because the coupling size of new cylinders has been maximized to nominal + 1 turn and the coupling size of in-service cylinders has been maximized to nominal + 2.0 turns.

5.2.4.2 Gauge design for socket head plugs

As the minimum insertion of socket head plugs is 6.6 mm above flush coupling and the maximum insertion is 4.4 mm under flush coupling, the gauge shall have the following dimensions (see Figures 18, 19 and 20):

- Check minimum insertion: **6.6** $^{0}/_{-0.1}$ **mm.**
- Check maximum insertion: **4.4** $^{0}/_{-0.1}$ **mm.**

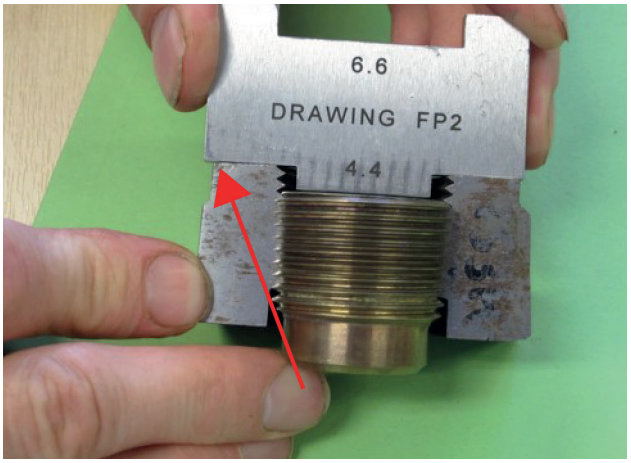


Figure 18: Example of a maximum installation gauge for a socket head plug.

A gap (see red arrow) must be observed to validate the installation.

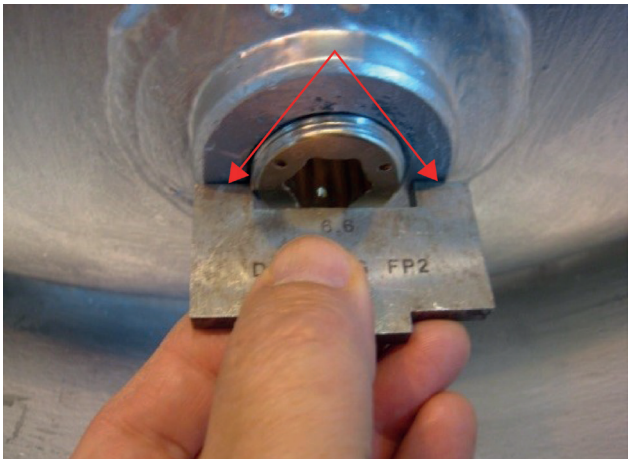


Figure 19: Example of a minimum installation gauge for a socket head plug.

No gap (see red arrows) must be observed to validate the installation.

Figure 20: Example of a minimum installation gauge for a socket head plug.

As a gap is showing between the outer surface of coupling and the gauge (see red arrow), the plug installation is not correct.

Note: As the weld may protrude over the coupling surface the gauge shown in Figure 20 is preferable.

5.2.4.3 Gauge design for valves

To design a gauge for checking valve installation, the valve manufacturers shall engrave the minimum reference dimension (between its reference surface and the valve inlet) on the valve body (named A) in millimeters.

Note: It is recommended for the purchaser to specify this minimum reference dimension to the manufacturer at the time of ordering valves. (see Figure 21).

Example calculation for dimensioning a 'No-Go' gauge: When the minimum reference dimension of a valve is A=37.7mm and the minimum number of threads to be inserted is 7, the maximum dimension of the 'No-Go' gauge is calculated as follows:

37.7(mm)-7 (threads) x 2.209 (mm/thread)=22.24 mm (≈ 22.2mm)

Thus, the dimension of the 'No-Go' gauge shall be: **22.2** $^{0\ /\ -0.1}$ **mm.**

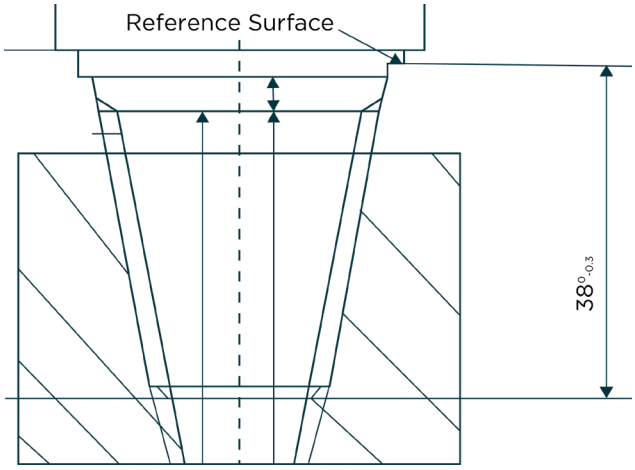


Figure 21: Example of a reference surface dimension for a valve.

The maximum insertion is limited to one visible thread left, but in some situations more clearance is needed to allow for installing and removing the port gap and the flexible connection to the process systems.

To ensure to have sufficient clearance the minimum value of the gauge has to be calculated from 13 effective threads. Thus, if a valve has more effective threads (14 or 15) the gauge will still guarantee the minimum clearance between the valve and the cylinder.

Example calculation for dimensioning a 'Go' gauge: When the maximum reference dimension of a valve is A=38 mm and the maximum number of threads to be inserted is 12, the maximum dimension of the 'Go' gauge is calculated as follows:

38(mm)-12 (threads) x 2.209 (mm/thread)=11.49 mm (≈ 11.5mm)

Thus, the dimension of the 'Go' gauge shall be: **11.5** $^{0\ /\ +0.1}$ **mm.**

Note: It is recommended to use a 'Go / No-Go' gauge to confirm the minimum and maximum thread insertion of the valve.

06

Installation Steps for Plugs

Step 1

After the coupling inspection (see Section 3) start to screw in the plug by hand to ensure there is no cross threading. Continue to fit the plug using a tool bit or a socket tool and a small ratchet spanner until tight (see Figures 22 and 23).

Figure 22: Example of insertion of a socket head plug by hand

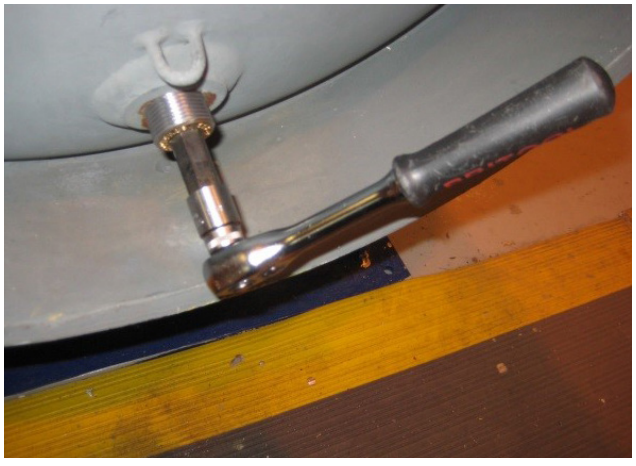


Figure 23: Example of insertion of a socket head plug with ratchet spanner till tight

Step 2

Attach the torque reaction hanging bracket to the cylinder, but do not tighten the locking screws which are located on the underside of the bracket (see Figure 24)

Figure 24: The torque reaction hanging bracket and locking screws

Step 3

Engage the tool bit or socket tool and torque device within the center of the plug and then tighten the bracket locking screws (see Figure 25).

This will secure the torque reaction hanging bracket in place whilst fitting the plug.

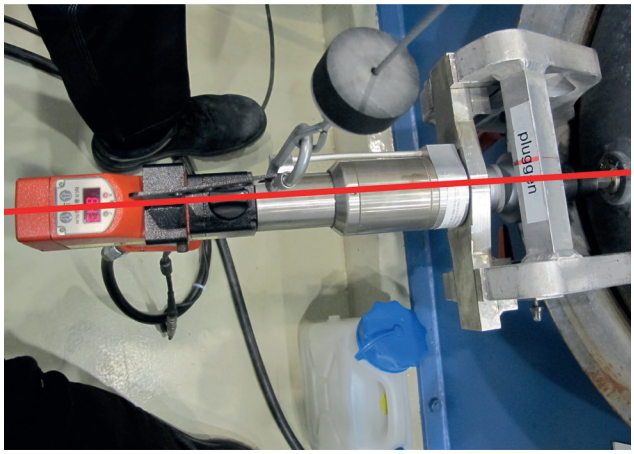


Figure 25: Example engaging the tool bit within the center of a socket head plug

Caution!!
During the installation process ensure the tool bit or the socket spanner is always fitted to the full depth of the socket / head of the plug. To enable full insertion of the tool bit or the socket spanner there must be sufficient clearance between the double sided reaction arm and the torque hanging bracket in order to allow the torque device to move forward as the plug is inserted (see Figures 26 and 27).

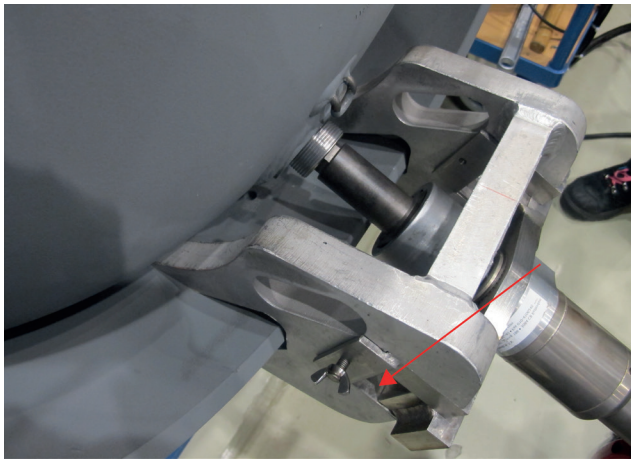


Figure 26: Clearance between the double sided reaction arm and the torque reaction hanging bracket.

Step 4

Install the plug by regular/uniform movement and low rotation speed (this reduces installation torques and improves leak tightness) until the thread minimum insertion limit within the torque range (see Table 1) has been reached. Then record the torque reading from the tool.

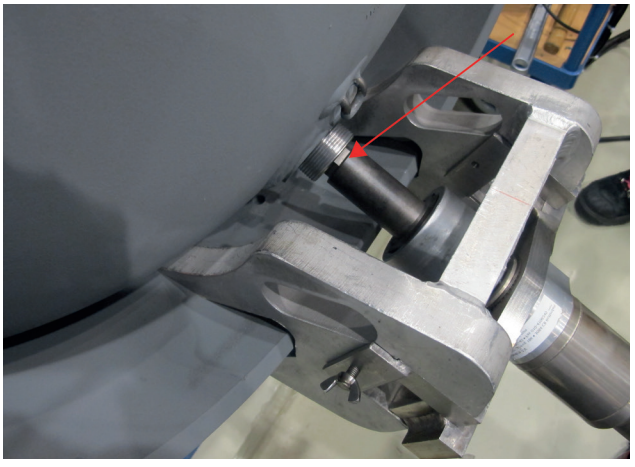


Figure 27

Step 5

It is recommended to confirm the plug thread insertion by using a Go / No-Go gauge as described in Section 5.2.4 (see Figure 28).

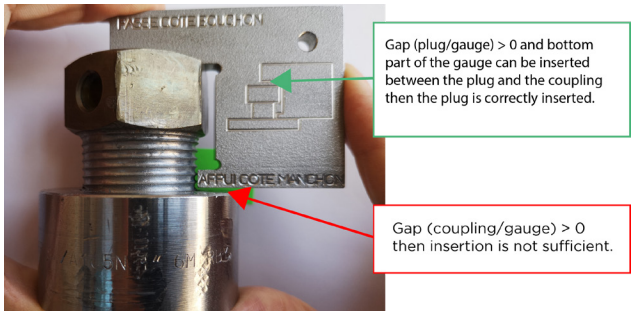


Figure 28: Example of an installation of a go/no go gauge for a hex head plug.

The scheme engraved on the gauge side explains the positioning of the gauge to validate a good insertion of the plug. The result here is: not ok.

Step 6

Perform a visual inspection of the plug installation. The socket shall show no large deformation or cracks (see Figures 29 and 30 which show acceptable deformation).

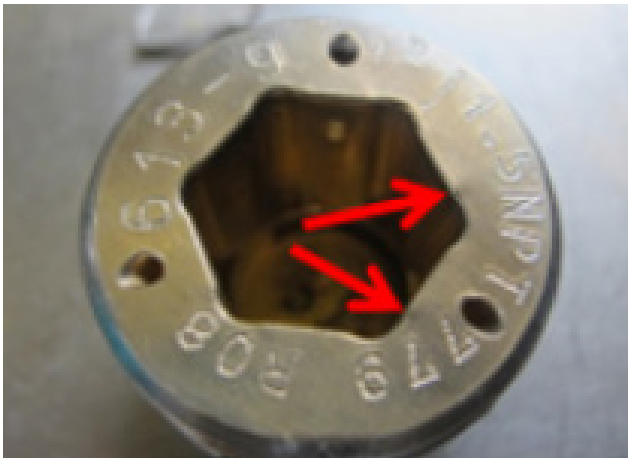


Figure 29: Example of acceptable deformation

Figure 30: Example of no deformation

Note: For socket head plugs deformation is more critical than for hex head plugs. So this step (No. 6) is especially applicable to socket head plugs.

Step 7

Perform a 7 barg leak test to confirm a leak tight connection. Following acceptance, the plug should be sealed.

07

Installation Steps for Valves (Type 51)

Step 1

After the coupling inspection (see Section 3) start to screw in the valve by hand to ensure there is no cross threading. Continue to fit the valve using a special adapter (see Figure 31) and a small ratchet spanner until tight.

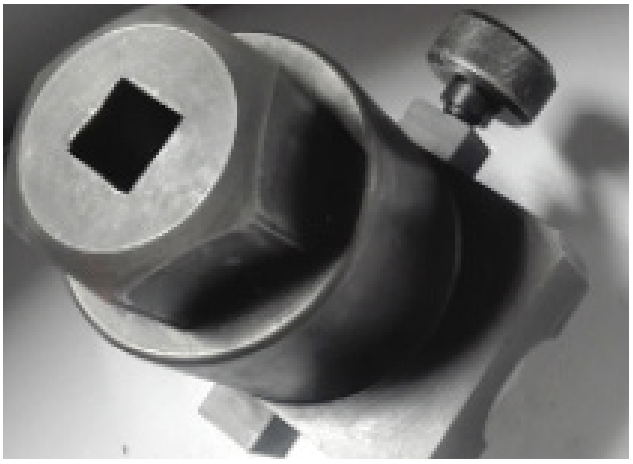


Figure 31: Example of a special adapter (without the ratchet spanner)

Step 2

If a double armed bracket is used refer to above installation instructions for plugs.

Note: It is recommended to install the valve by applying a step by step movement and low rotation speed (this reduces installation torques and improves leak tightness) until the thread insertion limit within the torque range (see Table 1) has been reached. Then align the valve outlet in the 6 o'clock position, within the torque range. Then record the torque reading from the tool.

Step 3

It is recommended to confirm the valve thread insertion by using a Go / No-Go gauge as described in Section 5.2.4.

Step 4

Perform a 7 bar (g) leak test to confirm a leak tight connection and valve seat. Following acceptance, the valve should be sealed.

08

Disclaimer and Recommendations

This guidance document has been prepared by WNTI Members and other stakeholders involved in the manufacture, use and maintenance of UF6 cylinders and related components and it is not a working instruction.

The official documents cited in the text must be consulted for a definitive description of their purpose and contents.

The information presented should be used by industry members to prepare specific working instructions for their facility operations.

Appendix 1

Damaged Socket Head Plugs

Figure 1: Example of an unacceptable deformation of the socket caused by too large of a gap between the tool bit and the socket

Figure 2: Example of a cracked socket caused by a tool which was not aligned in the axis of the socket during installation

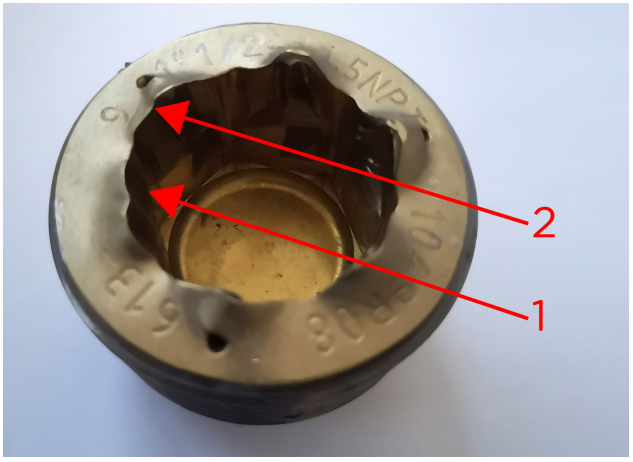


Figure 3: Example of an unacceptable deformation of the socket caused by tool bit which was not fully inserted during installation (1). One can see that the tool has been withdrawn during the installation (2).

Appendix 2

Quality of Tool Bits

Operational experience has shown that due to the high torques, 1" tool bits have failed during the installation process (see Figures 1 and 2 below). The root cause for these failures has been attributed to inadequate materials of construction, poor material heat treatment, and poor tool bit geometry. Therefore tool bits have to be properly dimensioned and made from high quality (hardened) materials (see Figures 3 to 5).

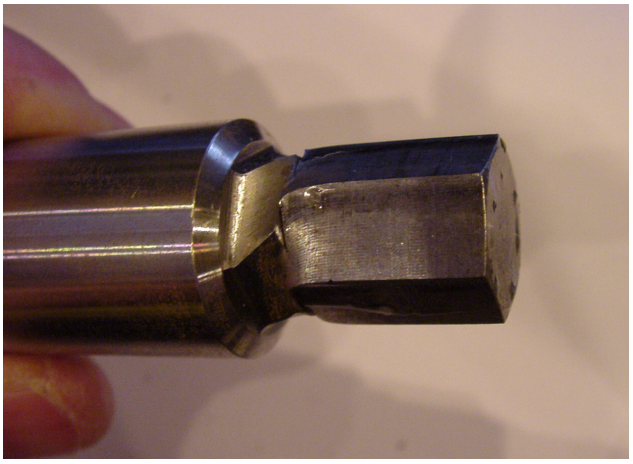


Figure 1: Distorted 1" tool bit

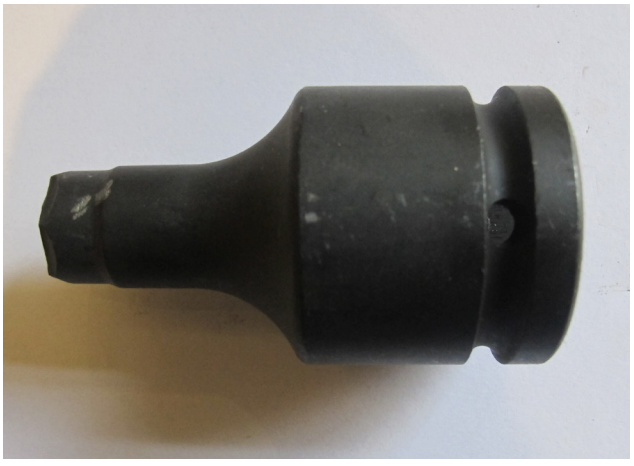


Figure 2: Broken 1" tool bit

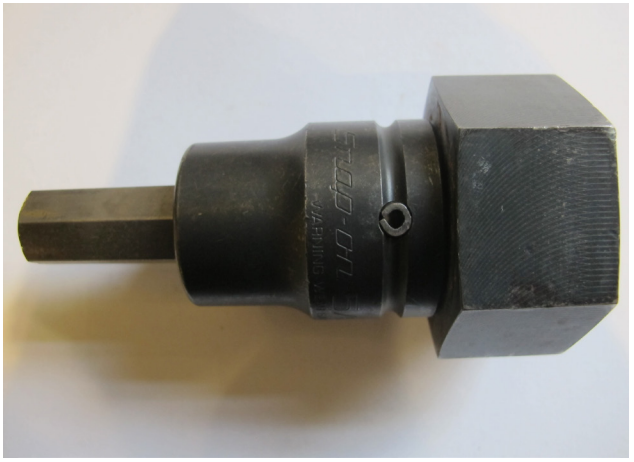


Figure 3: Example of a 1" hardened tool bit

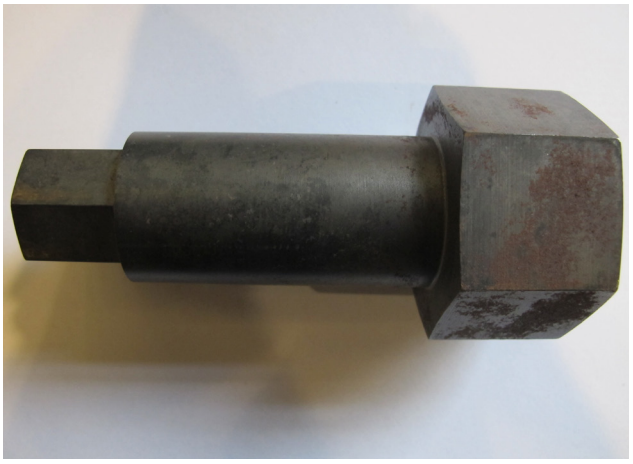
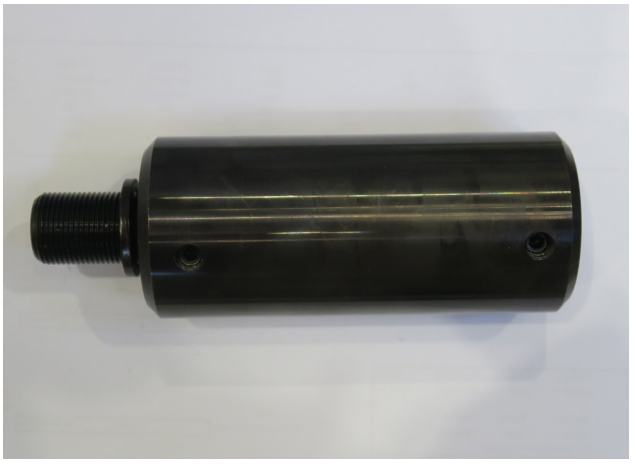


Figure 4: Example of a 1.5" hardened tool bit



Figures 5 a/b: Example of a hardened 1" tool bit with its hardened holder

Appendix 3

Recommended Tooling

PART / DRAWING NO	SUPPLIER / MANUFACTURER	DESCRIPTION
18114-BO8	Norbar Torque Tools Ltd	Ptm-72-2000-b-ic internal shut off tool
18293	Norbar Torque Tools Ltd	Double sided reaction plate
16704	Norbar Torque Tools Ltd	Lubro control unit
863-204001-00-00	URENCO	Urenco go / no-go gauge for socket head plugs
863-204006-00-00	URENCO	48Y cylinder hanging adaptor bracket for plugs
863-204007-00-00	URENCO	48Y cylinder hanging adaptor bracket for valves
863-204010-00-00	URENCO	Tool bit 1.5" Socket head plugs
863-204011-00-00	URENCO	Tool bit 1" socket head plugs
863-204012-00-00	URENCO	30B cylinder hanging adaptor bracket for plugs
863-204013-00-00	URENCO	30B cylinder hanging adaptor bracket for valves
863-204019-00-00	URENCO	Toolbit 1" hex head plugs
863-204021-00-00	URENCO	Toolbit 1.5" Hex head plugs
863-204024-00-00	URENCO	Urenco go / no-go gauge for 1" descote valves
AA433856	WESTINGHOUSE	Turner gauge
LD4835	WESTINGHOUSE	Torque adapter and key bit
LD4928	WESTINGHOUSE	Modification to norbar double sided reaction plate
200339718	Orano	Tool bit 1" Socket Head Plugs
200375325	Orano	Tool bit 1" Socket Head Plugs
19004962	Orano	Gauges for plugs and valves insertion
200197090	ENERPAC	Hydraulic wrench W2000
200201455	ENERPAC	Hydraulic wrench W4000

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