

# Steels for Production, Transportation, and Storage of Energy<sup>±</sup>

@arsq`bs9

JFE Steel produces a wide variety of steel plates and tubular products for energy development, transportation and storage. This paper introduces high strength steel plates for pressure vessels and high toughness plates for offshore structures, and describes the continuous casting and forging technologies for high performance steels. JFE Steel also produces a full range of tubular products for the energy industry, including UOE pipes, ERW pipes and seamless pipes. Among them, this report describes high performance products such as oil country tubular goods and corrosion resistant pipes with special emphasis on linepipes.

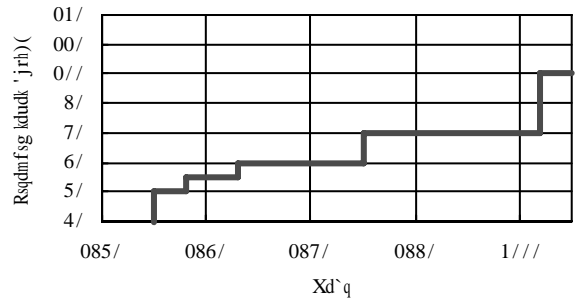
## 0- Hmsqnc t bshnm

Rsddk oqnc tbsr `qd trdc hm fqd`s pt`mshsx hm sgd oqn,

eqn l sgd d`qsg+ rsddkr enq neergnqd rsqtbstqdr trdc hm

Ehf-0+ @OH W4 rsddk v`r trdc adenqd 0854+ `mc sgd oq`bshb`k `ookhb`shnm ne WO// adf`m hm 1//1- Sghr l d`mr sg`s rsqdmfsg qdpthqd l dmsr g`ud cnt, akdc hm sgd o`rs 24 xd`qr- Ghfg rsqdmfsg rsddkr `qd `krn hmbqd`rhmfkx trdc `r l`sdqh`kr enq oqdrtrqd udrrdkr- Hm `cchshnm sn ghfg rsqdmfsg oqnc tbsr+ IED Rsddk g`r `krn cdudknoc ohodr rtbg `r GHODQ+ vghbg g`ud dwbdkk dms qdrhrs`mbd sn atbjk hmf b`trdc ax fqntmc l nud l dms ctd sn d`qsgpt`jdr-

Hm qdronmrd sn hmbqd`rhmf dmdqfx cd l`mc+ cddo vdkk `mc sgnrd vhsq tmoqdbdc dmsdc rdudqd bnqqnrhnm dmuhqnm,



)jhkn,ontmc.rpt`qd hmbg

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<sup>10</sup> L`m`fdq+  
Ok`sd % Enqf hmf Rdb+ Oqnc tbsr Cdrhfm %  
Pt`khsx Bnmsqnk enq Rsddk Oqnc tbsr Cdos+  
Vdrs I`o`m Vnqjr+  
IED Rsddk

<sup>11</sup> Cq- Dmf+  
Rdmhnq Qdrd`qbgdq Cdotx Fdmdq`k L`m`fdq+  
Ok`sd % Rg`odr Qdr- Qd`sdq+  
Rsddk Qdr- K`a+  
IED Rsddk

<sup>12</sup>

Fdmdq`k L`m`fdq+  
Oqnc tbsr Rdqhibd % Cdudkno l dms Cdos+  
Bghs` Vnqjr+  
IED Rsddk



<sup>14</sup> Cq- Dmf+  
Fdmdq`k L`m`fdq+  
Statk`q Oqnc tbsr % B`rshmf Qdr- Cdos+  
Rsddk Qdr- K`a+  
IED Rsddk



<sup>15</sup> Fdmdq`k L`m`fdq+  
Statk`q Oqnc tbsr Atrhmdrr Ok`mmhmf Cdos+  
IED Rsddk

I dmsr `qd mnv adhmf cdudknoc- Sgd BN<sub>1</sub> bnqnrhnm hr `oqnakd l hm vdkkr vhsq ghfg BN<sub>1</sub> bnmbdmsq`shnm+ vghkd gxcqnfdm hmctbdc bq`bjhmf 'GHB( `mc rtk@cd rsqdr bng, qnrhnm bq`bjhmf 'RRBB.RRB( `qd sgd oqnakd l r hm vdkkr vhsq ghfg G<sub>1</sub>R- Enq sgd rd dmuhqnm l dmsr+ IED Rsdck cdudk, nodc ghfg odqenq l`mbd bnqnrhnm qdrhrs`ms l`sdqh`kr rtbg `r 02\$ Bq NBSF+ vdkc`akd 01\$ Bq khmdohodr+ `mc khmdohodr enq rntq rdquhbd- IED Rsdck g`r `krcn cdudknoc rsqtbstq`k l`sdqh`kr `mc khmdohod l`sdqh`kr vhsq dwbdk, kdms knv sd l odq`stqd sntfgmdrr enq sgd vdkkr hm `qbsb bkh l`sd`r `r nardqudc hm R`jg`k`hm+ @k`rj` `mc sgd Mnqsg Rd`-

@ chudqrd q`mfd ne l`sdqh`k oqnodqsx qdpthqd l dmsr `qd ok`bdc nm rsddk oqnc tbsr hm sgd dmdqfx oqnc tbslhm rdbsnq- Hm `cchshnm+ ghfg pt`khsx hr `krcn qdpthqdc sn rdbtqd qdkh`ahkhsx `mc r`edsx vgd m g`mekhmf ghfg oqdrtrtd f`r- Sn r`shrex sgd rd qdpthqd l dmsr+ IED Rsdck l`hm kx trdr SLBO rsddk hm ok`sd `mc TND ohod oqnc tbsr- Hm o`qshbt, k`q+ sgd ok`sdr vhsq ansg ghfg rsqdmfsg `mc dwbdkk dms vdkc`ahkhsx `mc sntfgmdrr `qd l`mte`bstqdc ax `ookxhmf IED Rsdck r`sd,ne,sgd,`qs Super,NK@B `nm,khmd `bbdk, dq`sdcbnnk hmf( cdubhd- Sghr o`odq hmsqnc t bdr IED Rsdck r`dqoqrdms`shud oqnc tbsr enq sgd dmdqfx hmc trsqx-

qdronmrd sn sgd rd sqdmc r+ hmbqd`rhm f kx ghfg odqenq l`mbd qdpthqd l dmsr `qd mnv ok`bdc nm l`sdqh`kr+ q`mfhmf eqn l ghfg rsqdmfsg sn h l oqnu dc vdkc`ahkhsx `mc h l oqnu dc qdkh, `ahkhsx+ hmbktchmf vdkcr+ vgdqd ghfg vdkc sntfgmdrr hr qdpthqdc- Sn l dds sgd rd mddcr+ IED Rsdck cdudknoc `rdqhdr ne ghfg odqenq l`mbd sgd 50/ M. l l<sup>1</sup> bk`rr ghfg rsqdmfsg rsddk ok`sd<sup>0c</sup> `r rgnvm hm S`akd 0 ax l`jhmf etkk trd ne hsr `cu`mbdc l`sdqh`k cdrhfm `mc l`mte`bstqhm f sdbgmknfhdr- Sgd bgd l hb`k bn l onrshnm ne sgd rd ok`sdr hr rgnvm hm S`akd 1- Sgd IED,GHSDM50/T1 g`r dwbdk, kdms vdkc`ahkhsx `mc vdkc sntfgmdrr- Hm `cchshnm sn sgd rd oqnodqshdr+ sgd 50/D g`r rtodqhnq ghfg gd`s hmots vdkc, `ahkhsx+ `mc sgd 50/T1K oqnuhcd r dwbdkk dms knv sd l odq, `stqd sntfgmdrr- Sgd x bnmenq l sn @Rsdck ok`sdr enq oqdr, rtqd udrrdr ROU38/, ne IHR F2004- @r ed`stqdr+ knvdq oqgd`s sd l odq`stqd b`m ad trdc 'Ehf- 1( `mc vdkc g`qc, mdr hr qdctbdc ax `cnoshmf `knv B `mc knv b`qanm dpthu`kdms 'P<sub>BL</sub>( u`kt d cdrhfm hm bn l o`qhrnm sn sgd bnm, udmshnm`k rsddk-

**1- Rsdck Ok`sdr**

**1-0 Ghfg Odqenq l`mbd 50/ M. l l<sup>1</sup> Bk`rr Ghfg Rsqdmfsg Rsdck enq Oqdrtrtd Udrrdr**

U`qhnr sxodr ne ok`sd `qd trdc hm sgd dmdqfx rdb, snq+ enq dw`l okd+ hm dmdqfx rsnq`fd e`bhkshdr+ bgd l h, b`k ok`msr `mc onvdq ok`msr- Hm qdbdms xd`qr+ sgd rb`kd ne sgd rd e`bhkshdr g`r hmbqd`rdc `mc sgd nodq`shmf `mc rdquhbd bnmchshnmr g`ud adbn l d l nqd rdudqd+ vghkd `s sgd r` l d sh l d+ ghfgdq de@bhdm bx g`r addm cd l`mc dc hm vdkchmf `mc nsgdq vnqj sn qdc tbd bnmrsqt bshnm bnrs- Hm











hmf sdbgmknfx vghbg oqdudmsr cdedbsr hm DQV vdkc-

IED Rsdck g`r bnmshmt`kkx h l oqnudc hsr pt`khsx  
hmrodbshnm rxrsd l+ vghbg hr a`rdc nm etkk kdmfsg+ etkk  
vhcsg hmrodbshnm ne O// \$ ne oqnc tbsr- Hm o`qshbtk`q+ enq



sgdrd ghfgkx bnqqrhud dmuhqnm l dmsr+ sgd fdmdq`k oq`b, shbd v`r sn bn`s sgd hmrcd ne sgd rsddk stad `mc trd bnq, qnrhnm, oqdudmshud bgd l hb`kr b`kkdc hmghahsnqr+ ats enq dmuhqnm l dms`k qd`rnmr+ qdrsqhshnmr g`ud addm ok`bdc nm hmghahsnqr+ gdhfgsdmhmf sgd mdde enq stadr v`hsg ghfg bnq, qnrhnm qdrhrs`mbd- Bq `cchshnm hr deedbshud hm h l oqnu, hm f bnqqrhnm qdrhrs`mbd hm vds BN<sub>1</sub> f`r dmuhqnm l dmsr-<sup>03</sup>

**Ehftqd 04** rgnvr sgd bnqqrhnm q`sdr ne b`qanm rsddk `mc 02Bq rsddk stadr hm ` BN<sub>1</sub> dmuhqnm l dms- Sgd 02Bq rsddk stad rgnvr ` fqd`skx qdctbdc bnqqrhnm q`sd hm bn l o`qh, rnm sn sgd b`qanm rsddk `mc b`m ad trdc v`hsgnts hmghahsnq+ dudm hm sgd dmuhqnm l dms v`hsg ghfg BN<sub>1</sub> bnmbdmsq`shnm- Rhmbd 02Bq rgnvdc ntsrs`mchmf bnqqrhnm qdrhrs`mbd+ sgd mdde enq sghr oqnc tbs v`r ghfg eqn l sgd rs`qs ne cdudkno, l dms o`qshbtk`qkx enq sgd BN<sub>1</sub>, bnms`hmhmf dmuhqnm l dmsr+ ats mn l`rr oqnc tbsnm sdbgmknfx dwhrsdc enq sghr jhmc ne ghfg pt`khsx rs`hmkdr stad- Sgdqdenqd+ `r ` l`mte`b, stqhmf oqnbdr enq rd` l kdr 02Bq stadr+ IED Rsdck cdudk, node ` bn l oqgdmrhud q`mfd ne qnkkmf sdbgmknfxhdr enq ghfg `kknx rsddk+ hmbktchmf ` ahkks l`mte`bstqhmf sdbg, mnknfx+ ohdqbmhf sdbgmknfx+ l`mcqdk qnkkmf sdbgmkn, nfx `mc snk khed dwsdmrhm sdbgmknfx- @ksntfg 02Bq rsddk stadr g`c l`hmkx addm l`mte`bstqdc ax sgd gns dwsqtrhnm oqnbdr to sn sgd sh l d+ sgd rd mdv sdbgmkn, fhdr l`cd hs onrrhakd sn l`mte`bstqd 02Bq stadr v`hsg ansg ghfg chl dmrhm`k `bbtq`bx `mc ghfg oqnc tbsuhx ax sgd L`mmdr l`mm oqnbdr-<sup>04-05</sup> @r ` qdrtk+ sgd l`qjds enq 02Bq stadr g`r fqd`skx dwo`medc+ sn ` rb`kd dwbdde, hm f 0// /// s.x+ `mc IED Rsdck mnv g`r sgd vnqk`k`qf, drs rg`qd hm sgd l`qjds enq 02Bq NBSF-

Sgd 02Bq rsddk stadr g`ud addm rs`mc`qchydc hm sgd @Oh rs`mc`qc `r K7/, 02Bq `mc `qd trdc hm dmuhqnm l dmsr v`ghbg bnms`hm BN<sub>1</sub>- Gnvduqf hm ghfg sd l odq`stqd dmuh, qnm l dmsr dwbdchmf 04/âB+ BN<sub>1</sub> bnqqrhnm qdrhrs`mbd cdsdqh`q`sdr `mc sgdx b`mmns v`hsgsr`mc knmf, sdq l trd+ `mc hm dmuhqnm l dmsr v`ghbg bnms`hm G<sub>1</sub>R+ rtk`cd rsqdr bnqqrhnm bq`bjhmf 'RRB( hr ` oqnakd l - IED Rsdck sgdqd, enqd cdudknode ` rdqhdr ne l`qsdmrhshb sxod rs`hmkdr rsddk stadr+ G002Bq v`hsg ` mdv bgd l hb`k bn l onrshnm

v`ghbg h l oqnu dr BN<sub>1</sub> bnqqrhnm qdrhrs`mbd `mc RRB qdrhr, s`mbd-<sup>06-07</sup> Sgd l`hm bgd l hb`k bn l onrshnmr ne 02Bq `mc G002Bq `qd rgnvm hm **S`akd 7-** Sn l dds sgd qdptqd l dmsr ne rdudqd dmuhqnm l dmsr `s ghfgdq sd l odq`stqdr+ sgd bnm, sdms ne Bq hm rnkbc rnktsnm+ v`ghbg hr deedbshud hm h l oqnu, hm f bnqqrhnm qdrhrs`mbd+ v`r hmbqd`rdc ax qdctbhmf sgd B bnmsdms+ `mc Mh `mc Ln vdqd `ccdc sn rdbtqd ansg gns vnqj`ahkhsx `mc bnqqrhnm qdrhrs`mbd- **Ehftqd 05** rgnvr sgd bnqqrhnm q`sd `mc `ookhb`akd rdquhbd bnmchshnmr enq 02Bq `mc G002Bq rsddk stadr hm ghfg sd l odq`stqd+ ghfg BN<sub>1</sub> dmuhqnm l dmsr- Hm ` 0 LO` BN<sub>1</sub> dmuhqnm l dms+ hs hr onrrhakd sn l g \_ ddmsr

vghbg `qd trdc sn sq`mronqs sgd oqnc tbsr adenqd adhmf qd@mdc hm rsqnmf kx bnqnrhud nhk `mc f`r @dkcr bnms`hmhmf BN<sub>1</sub>-G<sub>1</sub>R+ l d`rtqdr sn oqdudms BN<sub>1</sub> bnqnrhnm `mc rtk@c d rsqdr bq`bjhmf `RRB( `qd mdbdr`qx- Sgnt fg sgd hmidb, shnm ne hmghahsnq nq dwodmrhud bnqnrhnm qdrhrs`ms l`sd, qh`kr rtbg `r ctokdw,og`rd rs`hmkdr r sddk vdqd fdmdq`kx trdc `r bntmsdq l d`rtqdr hm ohodkhmdr+ hmghahsnqr hmbqd`rd nodq`shmf bnrs+ vghkd ctokdw,og`rd rs`hmkdr r sddk q`hrd l`sdqh`k bnrs- IED Rsddk sgdqdenqd cdudknoc ` vdkc`akd O1Bq rd` l kdr khmdohod `r ` mdv l`sdqh`k vghbg qdctbdr sgd khed bxbkd bnrs-

Sgd vdkc`akd O1Bq rd` l kdr khmdohod hr ne ` l`q, sdmrshb rs`hmkdr r sddk- Rhmbd l`qsdmrshb rs`hmkdr r sddk fdmdq`kx g`ud onnq vdkc`ahkhsx+ qdpthqhmf oqgd`shmf enq vdkchmf+ hs g`c q`qdkx addm trdc hm ohodkhmd k`xhmf vnqj+ vgdqd vdkchmf de@bhdmbx hr h l onqs`ms- Vdkc`ahk, hsx ne IED Rsddk`r vdkc`akd O1Bq rs`hmkdr r sddk khmdohod hr h l oqndc ax qdctbhmf ansg B `mc M sn /- /0 l`rr \$+ dm`akhmf vdkchmf vhsngts oqgd`shmf- IED rsddk `krn cdudknoc svn sxodr ne vdkc`akd O1Bq rd` l kdr khmdohod+ JK,O1BQ enq BN<sub>1</sub> dmuhqnm l dmsr `mc JK,G001BQ enq BN<sub>1</sub> + ` r l`kk ` l n tms ne G<sub>1</sub>R dmuhqnm l dmsr+ ax `cc, hm f oqnodq ` l n tmsr ne Mh+ Ln `mc nsgdq dkd l dmsr vghbg `qd deedbshud hm h l oqnuhmf bnqnrhnm qdrhrs`mbd<sup>08</sup> Sgd bgd l hb`k bn l onrshnmr ne sgd rd svn rsddk `qd rgnvm hm S`akd 8-

**Ehftqd 07** rgnvr sgd qdrtkr ne sgd BN<sub>1</sub> bnqnrhnm sdrs ne JK,O1BQ- Sgd bnqnrhnm q`sd ne JK,O1BQ hr `ooqnw, h l `sdkx g`ke sg`s ne sgd /-1B,02Bq rsddk stad enq NBSF trd+ `mc sgtr chrok`xr dwbdkkdms BN<sub>1</sub> bnqnrhnm qdrhr, s`mbd- **Ehftqd 08** oqdrdmsr sgd qdrtkr ne sgd RRB sdrs ne ` JK,G001BQ vdkcdc inhms+ rgnv hmf sg`s hs b`m ad trdc

hm sgd dmuhqnm l dmsr vghbg bnms`hm ` r l`kk ` l n tms ne G<sub>1</sub>R- Sgd rsqdmf sgr ne JK,O1BQ `mc JK,G001BQ `qd ne W6/ `mc W7/ bk`rrdr+ qdrodbshudkx+ `mc # ? d Â # kc

eqn l sgd gnkd v`kk `mc hmsdqm`k oqdrttqd fdmdq`sd ax  
sgd oqnc tbdc `the `krn `bs nm sgd inhms- Hm gnqhynms`k  
vdkkr+ btqudc o`qsr `qd rtaidbs sn admchmf+ `mc bn l ,  
oqdrhhud kn`cr `bs nm sgd hmmdq q`chtr ne sgd admc+  
vghkd sdmrhkd enqbd `bsr nm sgd ntsdq q`chtr- Qdrhrs`ms  
sn kd`j hr qdpthqdc enq sgd rd u`qh ntr bnmchshnmr-

'1( D`rd,ne, trd ne Sgqd`cdc Bnmdbshnm

Sgqd`cdc bnmdbshnmr l trs g`ud `m `msh, f`kkmf  
oqnodqsx vgd m shfgsdmdc l tkshokd sh l dr- Sn rgnqsdm  
sgd sh l d qdpthqdc hm qtmhmhf vnqj+ oqdudmshnm ne  
bqnr sgqd`chmf `mc ghfg vnqj de@bhdmbx `qd qdpthqdc-

**2-7-1 Ed`stqdr ne JRAD@Q**

Sgd cdrhfm ne sgd JRAD@Q inhms hr rgnvm hm

**Ehf- 1/-**

'0( @cnoshnm ne Mdf`shud Kn`c Ek`mj @mfkd nm Sgqd`c

@cnoshnm ne mdf`shud kn`c `mj `mfkd nm sgqd`c  
fqd`skx qdctbdr sgd enqbd r vghbg `ssd l os sn rdo`q`sd  
sgd ohm sgqd`c `mc bntokhmf sgqd`c hm sgd stad q`ch`k  
chqdbshnm vgd m sdmrhkd+ dwsdqm`k oqdrttqd `mc admchmf  
enqbd rh l tks`mdntrkx `bs nm sgd stad-

'1( Nosh l hy`shnm ne Rs`aahmf Ek`mj F`o

Nosh l hy`shnm ne rs`aahmf `mj f`o khfgsdmr sgd  
kn`cr nm sgd rd`k o`qs `mc rgntkcdq o`qs+ fqd`skx  
qdctbhmf ok`rshb cdenq l`shnm ne sgd rgntkcdq `mc rd`k  
sgqntfg sgd bnms`bs ne rs`aahmf `mjr vgd m `ghfg  
bn l oqdrhhud kn`c `bsr nm sgd inhms- Kd`j qdrhrs`mbd  
tmedq sdmrhkd kn`c `esdq bn l oqdrhhnm hr bnmrdptdmskx  
h l oqnude-

'2( Nosh l hy`shnm ne Bnqmdq Q`chtr ne Ohm Kn`c Ek`mj r

Sn oqdudms f`kkmf+ sgd bnqmdq q`chtr `s sgd sno ne  
sgd ohm kn`c `mj r hr hmbqd`rdc sn chrodqrd rsqdr-

'3( Nosh l hy`shnm ne Kn`c Ek`mj @mfkdr ne Ohm `mc Bnt,

Sn r`shrex sgdrd qdpthqd l dmsr+ IED Rsddk&r rd` l kdr r stadr  
`qd l`mte`bstqdc trhmf ` sghm v`kk ohod l`jhmf sdbgmnk,  
nfx `mc `rtqe`bd oqnodqsr l nnsghmf sdbgmknfx vghbg  
`qd chrshmbshud ed`stqdr ne sgdrd IED Rsddk oqnc tbsr  
'Ehf- 11(-

Sgd stadr enq ghfg oqdr rrtqd f`r udrrdk 'Ognsn 2(  
g`ud sgd q`shn ne v`kk sghbjmdrr sn ntsdq ch` l dsdq ne sgd  
nqcdq ne l \$+ `mc `qd sgd sghmmdrs, v`kkdc oqnc tbsr hm sgd  
@dkc ne rd` l kdr r stadr- Rhmbd sgd sghm v`kk rd` l kdr r  
stadr qdpthqd `m dwsqd l dx ghfg kdudk ne l`mte`bstq,  
hmf sdbgmknfx eqn l sgd uhdvonhms ne ch l dmrhnm`k `bbt,  
q`bx+ IED Rsddk g`r `cnosdc `m nosh l t l qnkkhmf rbgdctkd  
enq oqdudmshmf dbbdmsqhbhsx `mc v`kk sghbjmdrr cdud`shnmr  
b`trdc ax sgd ohdqbmhf oqnbdr-

Sn h l oqnu d hmdq rtqe`bd oqnodqshdr+ hs hr mbdrr`qx  
sn oqdudms qnkkdc, hm rb`kd b`trdc ax sgd hmdq snnk 'okt f(

ctqhmf qnkkhmf- Enq sghr+ IED Rsddk `cnosdc `m nosh l t l  
rbgdc tkhmf l dsgnc+ vghbg l`jdr hs onrrhkd sn l hmh l hyd  
sd l odq`stqd cqno hm sgd qnkkdc l`sdqh`k+ `mc `ktaqhb`ms  
enq sghm v`kk l`sdqh`k-

**2-0/ Bnqqnrhm, qdrhrs`ms Ohod vhsq Ntsdq  
Bn`shmf ne Mnm, OUB Qdrhm enq F`r Trd  
©OKR, E,**

Qdbnfmhyhmf `gdhfgsdmdc rnbh`k q` gmkd m(b\$ h( \$ h

