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UNITED STATES  
NUCLEAR REGULATORY COMMISSION  
OFFICE OF NUCLEAR REACTOR REGULATION  
WASHINGTON, D.C. 20555

September 10, 1992

NRC INFORMATION NOTICE 92-68: POTENTIALLY SUBSTANDARD SLIP-ON, WELDING NECK,  
AND BLIND FLANGES

Addressees

All holders of operating licenses or construction permits for nuclear power reactors.

Purpose

The U.S. Nuclear Regulatory Commission (NRC) is issuing this information notice to alert licensees to problems with potentially substandard slip-on, welding neck, and blind flanges. It is expected that recipients will review this information for applicability to their facilities and consider actions, as appropriate, to avoid similar problems. However, suggestions contained in this information notice are not NRC requirements; therefore, no specific action or written response is required.

Description of Circumstances

On July 9, 1992, the NRC staff met with a representative of The National Board of Boiler and Pressure Vessel Inspectors (Board) to discuss the Board's investigation of problems associated with flanges that originated from the People's Republic of China. The Board has received numerous reports of flanges marked "China" that contain cracks, inclusions, and slugged weld repairs, and that were constructed from two pieces of material.

The suspect China flanges were sold to U.S. suppliers through several trading companies. Three of the trading companies identified were: Billiongold Company Limited of Hong Kong, Tain Gong Company, and Shanxi Province Overseas Trading Corporation. The suspect flanges were marked as forgings that complied with the requirements of the American Society for Testing and Materials (ASTM) Standard A-105, "Specification for Forgings, Carbon Steel, for Piping Components," and the American National Standards Institute (ANSI) Standard B16.5, "Dimensional Standards for Steel Pipe Flanges and Flanged Fittings." However, the suspect flanges were manufactured with ring-inserts welded to the inside diameter of the flange and the outer surfaces were machined. Consequently, a visual inspection would not detect either the welding or the two-piece construction. Other flanges were found with slugged weld repairs to the flange hub and still others failed to meet the material specification requirements for thermal treatment, mechanical properties, or chemistry.

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Discussion

The Board determined that one Chinese flange manufacturer, of the several known factories that supply the U.S., shipped more than 110 tons of ASTM A-105, ANSI B16, China flanges to this country. The Board stated that over 7,000 flanges are being removed from refineries and petro-chemical plants as a result of failures that occurred during welding, bolting, and hydrostatic and pre-operational testing. The Virginia Electric and Power Company informed NRC staff that China flanges are installed in two of its fossil power plants and others are in its warehouse. At the time of discussion, Virginia Power had not determined whether any suspect China flanges are installed in its nuclear power plants.

The NRC does not have evidence that any suspect China flanges have been installed in U.S. nuclear power plants. However, specific examples and discussions of the problems are attached for information.

A potentially substandard "China" flange can pass between two or more distributors before reaching the end-user facility. A nuclear power plant could buy a commercial grade China flange from a distributor to dedicate the flange for safety-related use, or safety-related components or subassemblies that contain China flanges could be supplied by licensee-approved manufacturers or fabricators. Establishing and verifying procedures to trace procured equipment and material to the original manufacturer or mill is an important prerequisite to inspecting and testing during the dedication process. It is possible for a licensee to install potentially substandard or defective equipment or material if it does not adequately verify that the product can be traced to the original manufacturer.

This information notice requires no specific action or written response. If you have any questions about this matter, please contact the technical contact listed below, one of the Board representatives listed on the attachments, or the appropriate Nuclear Reactor Regulation (NRR) project manager.

  
Charles E. Rossi, Director  
Division of Operational Events Assessment  
Office of Nuclear Reactor Regulation

Technical contact: Steven M. Matthews, NRR  
(301) 504-3191

Attachments:

1. 1992 Board article, "Failure Analysis of a Slip-On Flange."
2. Selected 1992 Board "NBBInfoletters."
3. List of Recently Issued NRC Information Notices

## FAILURE ANALYSIS OF A SLIP-ON FLANGE

*The installation of a 14" slip-on flange in a pipeline was recently witnessed by Al Justin, chief inspector for the State of Minnesota. The flange originally had a 14-3/4" inside diameter, which was reduced by welding a 3/4" ring and machine welding. The ring, however, separated from the flange, giving the appearance of a crack. The flange is reported to have been manufactured in the People's Republic of China.*

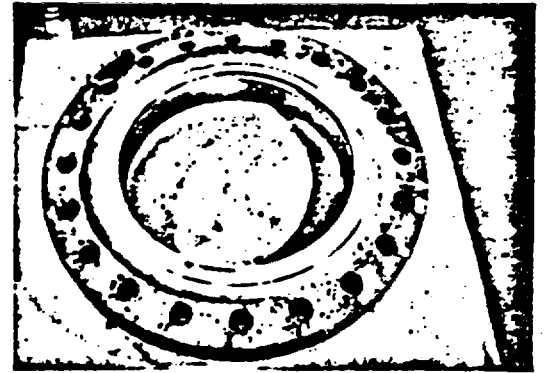


Figure 1: Gasket side of flange.

*Several such flanges have been reported in the field. All individuals in the industry should be on the alert for these flanges.*

*The following is a report by Columbus Metallurgical Services, Inc. on the failure analysis of a slip-on flange.*

A "cracked" 14" diameter slip-on flange was non-destructively inspected by using magnetic particle, dye penetrant and ultrasonic test methods. The flange was also checked for material chemical analysis and macro and microstructure. On the basis of the results and observations reported, the following conclusion is drawn:

The subject slip-on flange is not an integral forging or a casting. It has been fabricated by welding and machining a ring insert within a large diameter flange. The flange "cracked" because the welds between the flange and the insert were inadequate to withstand the bolting pressures.



Figure 2: A close-up of the gasket side showing the "crack" indication.

### BACKGROUND

The "cracked" slip-on flange was received by Columbus Metallurgical Services, Inc. in one piece. It had two diametrically opposite cracks located on pipe and gasket sides. It has been reported that several such flanges are in the field. The subject flange has the following engraved markings on the outside diameter (OD):

"14 300 SO RF B16.5 A105 848 CHINA 02F"

To identify the cause of the failure it was planned to perform dye penetrant, dry magnetic particle, ultrasonic and radiographic tests on the subject flange.

**NON-DESTRUCTIVE TESTS**

First, the flange was UT tested from the OD. The indications were rather puzzling because the reflections were consistently from a cylindrical surface about 3.75" from the OD. A dry magnetic particle examination confirmed that the cracks extended more or less continuously in a circular path. The NDT examination was concluded with dye penetrant tests as shown in the photographs in Figures 1 through 4. It was quite evident that the flange was not a single piece component. A large inside diameter (ID) flange was reduced to a 14" ID unit by welding a 0.75" thick ring. The welding faces had been machined.

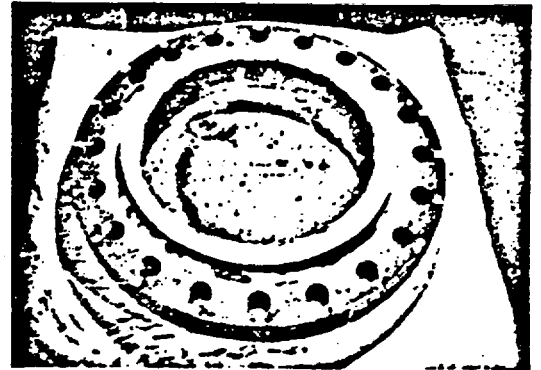


Figure 3: Pipe side of flange.

**CHEMICAL ANALYSES AND METALLOGRAPHY**

The flange was sectioned into four pieces to obtain specimens for chemistry, as well as for macro and microscopic examination. The original engraved markings have been retained on one of the segments. The chemical analyses are as follows:

C	Mn	P	S	Si	Cu	Sn	Ni	Cr	Mo	Al	V
<b>Main Flange Steel</b>											
.23	.62	.024	.038	.24	.27	.016	.094	.079	.026	.006	.003
<b>Welded Insert Steel</b>											
.26	1.02	.017	.039	.28	.063	.003	.050	.046	.032	.008	.000
<b>ANSI/ASTM A 105</b>											
.35	.60-1.05	.040	.050	.35	(listed for reference only)						



Figure 4: A close-up of the pipe side showing the "crack".

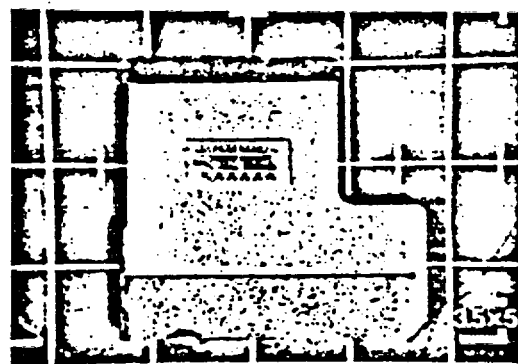


Figure 5: A macro of a radial section. Etched 50% HCl, 15 minutes.

Figure 5 shows the radial macro section of the flange. Note the insert ring welded to the main flange. When another similar piece was further sectioned to retrieve specimens for mounting and polishing, the insert separated from the main flange. The general microstructure (ferritic-pearlitic) at 25X (Nital etch) is shown in Figure 6.

#### ROCKWELL HARDNESS TEST

Main Flange:	72,69,70 HRB	Ave =
	70 HRB	
Insert:	76,78,80 HRB	Ave =
	78 HRB	

No further work was deemed necessary ♦

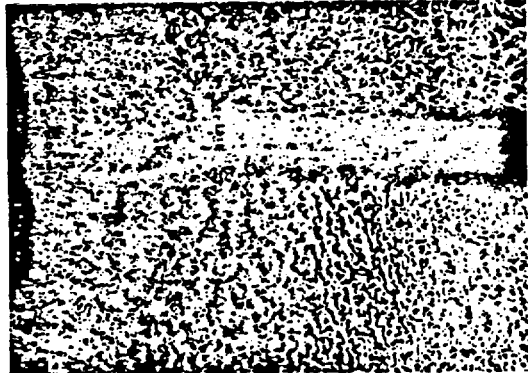


Figure 6: Photo showing general microstructure in the main flange (lower half), insert (upper half) and weld metal (left edge). 25X, Nital etch.



# NBBI Infoletter

VOLUME 1 - NUMBER 16 - 3/27/92

## Alert Continues for Flanges from China

The Winter 1992 *National Board Bulletin* included an article regarding a serious problem found to exist on 14" slip-on, raised-face flanges.

Since publication, NBBI has learned the problem described is only one of many associated with flanges from the Peoples Republic of China.

NBBI has been provided with a lab report for a 4" weld neck flange SA-105N B16-5 with a BHN (Brinell Hardness Number) of up to 500. Also, normalizing and chemistry requirements do not meet SA-105 requirements.

These flanges have been reported to have cracks and other surface discontinuities that might make them unfit for service. In addition, there have been reports that some flanges do not meet thickness requirements. NBBI also has been advised through reinspection reports that some flanges may not bear the markings re-

quired by the ANSI B16 specification, although they do bear the B16 mark.

NBBI advises double-checking all flanges with the marking "China," especially before these flanges are placed in service.

Certainly, flanges that have visible surface discontinuities or incomplete markings may be easy to see. But the machined surfaces of welded flanges can only be detected through a volumetric form of NDE. The failure to meet heat treat, mechanical or chemical requirements of the specifications can only be verified through metallurgic examination.

This update is being distributed in the interest of public safety. Future updates will be published as more facts are learned.

Further questions or concerns should be directed to A.M. "Doc" Matthews, Jr. or R.D. Schueler, Jr. at National Board headquarters.

## Number of Suspect Flanges Growing at Alarming Rate

The National Board continues to receive reports of several different types of flanges, ranging in sizes from 2" to 20" and marked "China," that do not appear to be in accordance with ANSI B16 as markings.

As the number of suspect flanges continues to grow, so does the different types of problems related to these flanges.

To date, over 7,000 have been removed from service, including 1,600 recently discovered in a newly-installed pipeline. An injunction has been ordered to cease work on the pipeline until the flange problem has been resolved. The remaining 5,200+ flanges have been found mostly in refineries.

The president of the China Association of Boiler and Pressure Vessel Inspection, Center of Boiler & Pressure Vessel Inspection & Research of the Ministry of Labour, P.R.C., Wang Hannuo, has agreed to meet with National Board Assistant Director of

Inspections John McLouglin, late in May in Beijing to discuss the problem.

NBBI continues to advise double-checking all flanges with the marking "China," especially before these flanges are placed in service.

Flanges that have visible surface discontinuities or incomplete markings may be easy to see. But the machined surfaces of welded flanges can only be detected through a volumetric form of NDE. The failure to meet heat treat, mechanical or chemical requirements of the specifications can only be verified through metallurgic examination.

NBBI will continue to publish updates as information is learned. This update is distributed in the interest of public safety.

Further questions or concerns should be directed to A.M. "Doc" Matthews, Jr. or R.D. Schueler, Jr. at National Board headquarters. □

## Flange Update: McLoughlin Meets Chinese Boiler/Pressure Vessel Officials

John D. McLoughlin, assistant director of inspections, met with several agencies of the Chinese government during his recent visit to the Peoples Republic of China. The visit was to discuss problems with flanges manufactured in China (and distributed to the U.S.).

Two meetings were held in Beijing.

On May 28, 1992, McLoughlin met with officials of the Center of Boiler and Pressure Vessel Inspection and Research, as well as representatives of Shanxi Province Overseas Trading Corporation, Tian Gong Company and Ding Xinang Nan Xi Li Flange Company.

Mr. McLoughlin learned that Ding Xinang Nan Xi Li has shipped seven to eight containers (each with 17 tons of various types and sizes of flanges) to the U.S. through what is believed to be Jacksonville, Florida. Shipping was reportedly provided by Shanxi Province, Tian Gong and Billiongold (a Hong Kong trader with Beijing offices).

Mr. Yang Li Min of Shanxi Province Overseas Trading Corporation reported that the base material for these flanges was 25 MN and possibly 16 MN (both Chinese forging specifications) and not the A105 identified on both the flanges and material test reports.

It was stated by Mr. Yang Li Min that manufacturing identification on the flanges was specified by Billiongold (the Hong Kong trader) and not the flange manufacturer.

A second meeting was arranged for Mr.

McLoughlin by Mr. Su Rung Ji, vice premier of China. Mr. McLoughlin met with Mr. Zheng You Mei, director of the Reception Bureau, State Council, P.R.C., Ms. Fan Jia Nian, assistant director of the Reception Bureau, and several members of the Center of Boiler and Pressure Vessel Inspection and Research (representing the Ministry of Labor). CBPVIR has been assisting the National Board in its investigation.

The director of the Reception Bureau was given copies of information accumulated during the course of Mr. McLoughlin's investigation and provided with a brief explanation of the documents and the significance of each.

Mr. Zheng You Mei reported that Mr. Su Rung Ji has a great interest in the flange situation. He said the government appreciated the information provided by the National Board. Mr. Zheng You Mei also said that a complete report of the meeting would be provided to Mr. Su Rung Ji.

The meeting concluded after Mr. McLoughlin provided Mr. Zheng You Mei with recommendations on steps the government could take to assure that steel mills and forging makers produce material and flanges that meet ASTM and ANSI specifications. The National Board will be advised when or if these recommendations will be implemented.

Upon his return to the U.S., Mr. McLoughlin received the laboratory results of blind flange and slip on flange tests that were ordered prior to his departure. Results of these tests are as follows:




*Flanges continued ...*


1. Blind flange with an identifier of "PF" and marked A105 is reported to be a plate material.

2. Slip on flange with an identifier of USC or USIO and a heat #I-406 contains slugged weld repairs. The W weld repair indicator required by A105 is not stamped on the flange. The chemistry does not meet A105. The mill report does not indicate any type of heat treat even though the flange is marked A105N and has also been "weld repaired." Finally, photo micrographs indicate plate material. The flange makers name is Shou Gang Machinery Engineering Company.

According to Mr. McLoughlin: "This office has probably accomplished all it can at this point, with the resources available. The National Board will publish a special edition of *The National Board Bulletin* that will address this problem. Hopefully, we will be able to report steps the Chinese government are taking to insure that their flange products meet specification."

The National Board will be providing various appropriate agencies of the U.S. government with information it has acquired through the investigation process. □



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LIST OF RECENTLY ISSUED  
 NRC INFORMATION NOTICES

Information Notice No.	Subject	Date of Issuance	Issued to
92-67	Deficiency in Design Modifications to Address Failures of Hiller Actuators Upon A Gradual Loss of Air Pressure	09/10/92	All holders of OLs or CPs for nuclear power reactors.
92-66	Access Denied to NRC Inspectors at Five Star Products, Inc. and Construction Products Research, Fairfield, Connecticut	09/01/92	All holders of OLs or CPs for nuclear power reactors and all recipients of NUREG-0040, "Licensee, Contractor and Vendor Inspection Status Report" (White Book).
92-65	Safety System Problems Caused by Modifications That Were Not Adequately Reviewed and Tested	09/03/92	All holders of OLs or CPs for nuclear power reactors.
92-64	Nozzle Ring Settings on Low Pressure Water-Relief Valves	08/28/92	All holders of OLs or CPs for nuclear power reactors.
92-63	Cracked Insulators in ASL Dry Type Transformers Manufactured by Westinghouse Electric Corporation	08/26/92	All holders of OLs or CPs for nuclear power reactors.
92-62	Emergency Response Information Requirements for Radioactive Material Shipments	08/24/92	All U.S. Nuclear Regulatory Commission licensees.
92-61	Loss of High Head Safety Injection	08/20/92	All holders of OLs or CPs for nuclear power reactors.
92-60	Valve Stem Failure Caused by Embrittlement	08/20/92	All holders of OLs or CPs for pressurized water reactors (PWRs).

OL = Operating License  
 CP = Construction Permit