14. WEIGHT.

The overweight of each lot * in each shipment shall not exceed the amount given in the following table. One cubic inch of rolled steel is assumed to weigh 0.2833 lb.

PERMISSIBLE OVERWEIGHTS OF PLATES ORDERED TO THICKNESS

Specified Thickness, inches	Permissible Excess in Average Weights per Square Foot of Plates for Widths Given, Inches, Expressed in Percentages of Nominal Weights								
	48 or under	Over 48 to 60, excl.	60 to 72, excl.	72 to 84, excl.	84 to 96, excl.	96 to 108, excl.	108 to 120, excl.	120 to 132, excl.	132 to 144, excl.
7/32 to 1/4, excl.	...	8	9	10	12	...	...	...	...
1/4 to 7/32, excl.	6	7	8	9	10	12	14	16	19
7/32 to 3/8, excl.	5	6	7	8	9	10	12	14	17
3/8 to 7/32, excl.	4.5	5	6	7	8	9	10	12	15
7/32 to 1/2, excl.	4	4.5	5	6	7	8	9	10	13
1/2 to 5/8, excl.	3.5	4	4.5	5	6	7	8	9	11
5/8 to 3/4, excl.	3	3.5	4	4.5	5	6	7	8	9
3/4 to 1, excl.	2.5	3	3.5	4	4.5	5	6	7	8
1 to 2, incl.	2.5	2.5	3	3.5	4	4.5	5	6	7

*The term "lot" applied to the above table means all of the plates of each group, width and group thickness.

V. FINISH

15. FINISH.

The finished material shall be free from injurious defects and shall have a workmanlike finish.

VI. MARKING

16. MARKING.

a. The name or brand of the manufacturer, the manufacturer's test identification, class and lowest tensile strength specified, shall be legibly stamped on each finished plate in two places not less than 12 in. from the edges and on each butt strap near the center line not less than 12 in. from each end. The manufacturer's test identification number shall be legibly stamped on each test specimen. Plates cut from the same slab shall be numbered serially.

b. When specified on the order, plates shall be match-marked as defined in paragraph (c) so that the test specimens representing them may be identified. When more than one plate is sheared from a single slab or ingot, each shall be match-marked so that they may all be identified with the test specimen representing them.

c. Each match-mark shall consist of two overlapping circles each not less than 1½ in. in diameter, placed upon the shear lines, and made by separate impressions of a single-circle steel die.

d. Match-marked coupons shall match with the sheets represented and only those which match properly shall be accepted.

VII. INSPECTION AND REJECTION

17. INSPECTION.

a. All tests and inspection shall ordinarily, and so far as possible, be made at the place of manufacture prior to shipment.

b. The purchaser may make tests to govern the acceptance or rejection of the material in his own laboratory or elsewhere. Such tests shall be made at the expense of the purchaser.

c. The manufacturer shall notify the Engineer of Tests of the Railroad at least four (4) days in advance of the time when material will be ready for shipment to permit of arrangements for inspection.

d. The inspector representing the purchaser shall have free entry to all parts of the manufacturer's works which concern the manufacture of the material ordered while the work on the contract of the purchaser is being performed.

e. The manufacturer shall afford the inspector, free of charge, all reasonable facilities and necessary assistance to satisfy him that the material is being furnished in accordance with these specifications.

18. REJECTION.

a. Material represented by samples which fail to conform to the requirements of these specifications shall be rejected.

b. Material which, subsequent to test and inspection at the factory or elsewhere and its acceptance, shows manufacturer's defects shall be rejected and the manufacturer notified. In case of rejection after arrival of the material at destination, the manufacturer shall pay all transportation charges.

19. REHEARING.

Samples tested in accordance with these specifications, which represent rejected material, will be held for fourteen (14) days from date of test. In case of dissatisfaction with the results of the tests, the manufacturer may make claim for a rehearing within that time.

COMMENTS CONCERNING PRACTICE OF A MANUFACTURER RELATING TO APPLICATION OF STAYBOLTS IN NEW BOILERS

By R. J. McNAMARA

After the side sheets are straightened, our Tool Room furnishes us with a set of 24 staybolt taps. These taps are held to a tolerance of .001 and are ordered long enough so as to assure a continuous lead through both sheets.

Next, a hole is tapped with each individual tap, using a motor of approximately 300 r.p.m's. Test bolts are made to fit, usually a snug pull with a 12" wrench. This is usually put up to the customer's inspector so everyone concerned will be satisfied. We ordinarily find that to insure a snug fit, our bolts will run approximately .002 over specified size. This is due to reaming and tapping, which in most cases causes the tapped hole to be slightly over size.

After the "fit" is established, our Bolt Room proceeds to cut one set of bolts; meanwhile the staybolt men ream and tap four vertical rows of staybolt holes using a good lubricant. After the threads in both sheets are sufficiently clean, the bolts are then applied and, if any variation in size, the taps are immediately replaced. The staybolt men proceed to tap four more rows, etc., until the sides are finished.

We do not use squares on the end of our bolts but use the plain round stock. This enables us to have a better chance of centering the bolt in our threading machines. This necessitates using a small alligator chuck in motor to apply bolts which gives us a satisfactory job all around.

We set our bolts approximately two and one-half to three threads on fire side which gives us a uniform thread to drive. All bolts on outside are flame cut to about the same length.

In applying flexible stays, the holes are reamed, tapped and cleaned,

then inspected. The bolts are applied and then backed off according to specifications.

Too much attention cannot be given to driving a bolt. After all the attention that is given to applying a bolt, it is all for naught if in driving it, a hanhazard job is done. We obtain best results by using a "sixty" hammer with a fairly flat die and a heavy bucking-up bar, making sure that each man, both driver and bucker, are on the same bolt at the same time.

As to the seal welded staybolt, I have no experience with these as yet, but "Lima's" next order coming up requires seal welding on fire side from mud ring up to center line of boiler. I think this procedure, if followed up, will be the answer to leaky bolts in the fire line.

My own ideas concerning seal welding of staybolts would be a slight countersink on the fire side, then run the bolt through the sheet approximately $\frac{1}{16}$ inch past flush — upset bolt in center, then seal weld.

APPLICATION AND MAINTENANCE OF STAYBOLTS

By W. H. East

Fabrication of Firebox Sheets

Although the general practice of locomotive builders and various railroads, in the fabrication of firebox sheets, designate that staybolt holes be drilled, our standard method is to punch staybolt holes ¼" diameter smaller than the diameter of threaded ends of bolts, which are to be applied. To date, this method has been very satisfactory.

The firebox plates are purchased, in accordance with A.A.R. Specifications, with minimum tensile strength of 48 000 lbs. Special alloy steel plate for fireboxes, has never been used up to the present time.

These holes are reamed, after punching, to allow end of tap to enter easily, and to remove any possible invisible cracks around circumference of holes, which may have developed when being punched. Drilling the staybolt holes will assure that cracks, as mentioned above, would not develop, but this operation requires much more time to complete.

Staybolt Taps

Our standard thread is, National Form Type, with 12 threads per 1". All taps used are purchased under certain specifications, and are not acceptable, if they are less than normal size, nor more than .002" above, for sizes under 1", or .003" for 1" or above. The pitch diameter of taps, is the gaging point. Staybolt holes are tapped from the exterior of firebox with pneumatic machine operating at 320 to 360 revolutions per minute.

Staybolt Specifications

Staybolt material is of approved hollow bar-iron A.A.R Specification M-304-39; the tell-tale holes, of which have a diameter of $\frac{7}{32}$". Rigid bolts with continuous thread, flexible bolts with reduced bodies, and crown bolts with taper at firebox end, are all purchased ready for application. We do not make any staybolts, except in an emergency.

The tolerance allowed on threaded ends is .002" maximum and .002" minimum above or below required sizes. Bolts with reduced bodies have a tolerance of .015" maximum and .015" minimum, at reduced portion, above and below required sizes.

All tell-tale holes must not be over $\frac{1}{16}$" out of center, which includes crown type, rigid type and flexible type bolts.

Crown bolts are tapered (2" in 12") in crown sheet fit, with 1⅛" threaded ends and $1\frac{15}{16}$" diameter at reduced body. This is the smallest crown bolt used.

Application of Staybolts

When old holes in outside sheets are over size, that is, holes to which rigid bolts are to be applied, they are brought back to nominal size by either electric or acetylene welding. The initial size of staybolts applied is 1" diameter on threaded ends. This does not mean that renewal of side sheets would require exterior holes to be welded. In this incidence, a $1\frac{1}{16}$" diameter bolt would suffice.

After an application of 1" diameter stays, renewals gradually increase in sizes up to 1¼", however, $1\frac{3}{16}$" and 1¼" diameter bolts are used sparingly, and these, in scattered locations, used only in roundhouses to expedite dispatchments.

New staybolts must be reasonably tight in sheets before driving. An allowance of ¼" is made on bolts, beyond sheets, for driving heads, which is done with at least a number 60 long stroke pneumatic hammer, and bucked with a 46 pound holding bar.

Flexible staybolts are not applied extremely tight. Those applied around syphon and circulator diaphragms are backed off one and one-quarter turns. We also find that snapping of staybolt heads after driving, remove the ragged edges which if not removed have a tendency to curl from the heat. This is especially so where bolts may be re-driven and are thinned out at edge of heads.

Tell-tale holes are re-opened and countersunk, both inside and outside, where rigid bolts are applied, and on inside where flexible type bolts are applied. Porous plugs are applied to tell-tale holes. It is essential that staybolts and driven heads be kept as small as possible to avoid heating and leakage.

Maintenance of Staybolts

Complete application of flexible type bolts show minimum breakage. Average breakage is two bolts per month. In fireboxes partially equipped with flexible bolts more breakage of rigid bolts was experienced. These were located in the straight rigid radials between the crown bolts and flexible bolts in breakage area, at top of side sheets. This condition was corrected by three rows of additional flexible bolts.

Leaky Staybolts

Little trouble is experienced with leaky staybolts. Of course, there are periods of dry weather when water becomes more acid and causes staybolts to leak. These will appear at fireline on side sheets and scattered around firebox including crown bolts. If any firebox at this time shows excessive leakage, the staybolts are re-driven and held on with bucking bar. As this condition does not usually last too long, staybolt leakage is reasonably allowed, to keep from ruining staybolts from excessive driving, and when quality of water improves, all leaking stops. As a whole, leaky staybolts are generally few.

Hot workers in Roundhouses should refrain from striking any leaky bolt with hand hammer, both as a safety measure and for the reason that bolts can be ruined, and desired correction not accomplished by this unworkmanlike method.

Leaky staybolts can also develop on lower portions of side sheets by careless fireknockers with wash down hose when removing cinders from ash pan wings if they allow water to strike hot side sheets. To eliminate this condition, grates should be closed after they have been cleaned, which would not only keep water off the fireside of sheet, but would also prevent

excessive cold drafts passing through firebox, while locomotive is on way to roundhouse.

Cinder Cutting of Staybolt Heads

We have little difficulty originating from cinder cutting of staybolts heads. Until the last three years there was none, however, the recently purchased mallets developed cinder cutting on the Thermic Syphons at top portion, due to high velocity of gases in this area. This condition is noted on the three rear syphons in firebox, and rear syphon in combustion chamber.

Further cutting has been prevented of staybolt heads by spot-welding semi-circular ¼" diameter wire at rear, ⅜" from edge of head. The crown bolts to date have not cinder cut. This is the only trouble we have experienced in cinder cutting relative to staybolts.

Water Treating

As the Company has numerous water treating plants all over the system, this is a great factor in preventing staybolt leakage. Water is tested twice daily relative to chemical properties, and from this analysis the amount of soda ash and lime is determined, to be added to the feed water.

In dry seasons, when foaming is noted, the above treatment is not wholly adequate. Under these circumstances, anti-foam compounds, Dearborn No. 665 and Nalco D are used. This is put into tank prior to filling tank when locomotive is dispatched. Two ounces per 1000 gallons are used; the entire amount determined by the capacity of the tank.

Corner blow-off cocks are located on the left back corners of firebox end, operated by the fireman, and are opened at intervals of 15 seconds after an elapsed number of miles, depending on kind of service engine is operating. In freight service, the blow down is every 7 miles, in passenger service, every 15 miles and in yard service every hour. These operations all have a tendency towards maintenance of the locomotive firebox. A rainy period will clear up the condition, relative to foaming.

Alloy Staybolts

To date we have no installation of seal-welded staybolts. However, one firebox of freight locomotive, is equipped with Mayari steel bolts, which have only been in service three months. This short length of time is not sufficient test for comment. This is a complete flexible type bolt installation.

Maintenance of Firebox Sheets

Our extensive water treatment of feed water eliminates excessive scale from adhering to firebox sheets and bolts. We are not troubled with pitting of sheets, and side sheets last 4 to 6 years before renewal. Believe, this life could be extended had we a surplus of power as some railroads have, and larger capacity boilers, but, as the majority of road power have 78" boilers or less, with exception of mallets and Santa Fe types, and excessive number of grades, we believe that this type of maintenance is satisfactory under these conditions.

It is considered that 13 years is the life of a mallet crown sheet, and 15 years on all other types of power. This does not mean that crown sheets are removed at above length of service. At the expiration of the time specified, if after inspection sheet appears good, it is allowed to remain. There are quite a few locomotives operating today with crown sheets 20 years old. These are mostly on smaller power of the 2-8-2 type.

In some instances, it is necessary to renew crown sheets under the above specified time, due to small cracks developing out of holes, but first patches are applied, if defects can be removed within a reasonable area. This same condition is also true for side sheets. Cracks developing in side sheets are welded if not over 8" long until such a time that they are considered numerous, and either sheets are patched or renewed, depending on concentration of developed cracks. Engines in road service would logically require more frequent repairs than yard engines.

CONCLUSION

In conclusion, water treatment and blow-down of boilers help greatly in the maintenance of boilers. Scale and mud, at wash-out periods, is very little. Too rapid cooling of boilers and washing out with cold water can develop unnecessary leaks. The temperature of wash out water on our railroad must be 100 degrees or more. The same temperature is used to fill boilers.

FOLLOWING PRACTICES OF STAYBOLT APPLICATION, ERIE RAILROAD

By S. S. McConnell

Our railroad has had leaking staybolts and at this time we have corrected most of our trouble. We use iron staybolts hollow, which are to the attached specification. We use 100% water treatment, which is internal treatment that consists of tannin and other organic alkaline salts. Each individual water supply is analyzed and treated according to analysis. Our dissolved solids run from 42 maximum grain hardness to 1 grain minimum. We blow our boilers so engines leave the terminal with 75 dissolved solids. On our railroad the water treatment company has three men checking water at all times and the railroad company has one man assigned or if any trouble occurs, as many as needed to correct any trouble. Samples from each terminal are sent into the railroad laboratory for analysis each week.

Our Practice of Applying Bolts. We use taps with thread U.S. standard form maximum size on new work not to exceed 1 1/16" diameter. Threads standard gauge size within a tolerance of plus .000 or minus .003 on pitch diameter, and plus or minus .0015 per inch of length for variation in lead of thread. All staybolt holes are drilled in sheets ⅛" smaller than tap size. We tap all holes from outside in at a speed to insure good threads. We use a vegetable tapping compound (no white lead), start tapping at the bottom after some scattered holes are tapped and bolts applied to stay sheets. Tap four (4) rows and blow out each hole, run in four (4) rows of bolts and set to gauge, continue four (4) rows until application is made. After all bolts are applied setting is checked with gauge and ends cut off on outer end with acetylene cutting torch.

The following operation is for driving heads and we use a 40 lb. bucking bar with a die in end to insure that the bar is on head of bolt at all times and held with pressure against the bolt. We drive the fire box side first with a No. 60 or No. 80 air hammer, the bucking bar suspended on a rope cable on a pulley and a balanced weight, after each head is driven we cup the edge of the bolt head. My idea in applying bolts is that when tapping holes is to keep the weight of the motor off the tap, we suspend our motors so that tap does not ride and make an elongated hole. All our bolts are threaded by the manufacturer and kept in the storehouse, and as bolts are needed we order and same are delivered to engine in boxes.

When we were having trouble with leaking staybolts we found we were getting oil into the boilers account of heater lines being piped off of a line receiving oil from the lubricator and the exhaust steam carrying same through the Elesco heater back through the condensate line to the water tender. This has all been corrected.

We also found that ashpit men were using water pumps around terminals while engines were standing.

Our large freight engines are of the 2—8—4 type, with top boiler check, type "E" flues and equipped with two syphons, carrying 250 lbs. boiler pressure, with 5699 square feet of heating surface.

I would like to mention at this time we are having considerable trouble with our steel in fire box sheets that was purchased during the war period. We are getting a better grade of steel at this time. We also have several engines on test with Moly Steel, ¾ side sheets, which have only been in service a few months and I am not able to state any report as to service at this time.

Erie Railroad Company:—

Specifications Staybolt Iron:
Manufacture:—

Process: The bars shall be rolled from a bloom, slab pile or box pile, made from reworked wrought iron, or from reworked knobbled charcoal iron. The original muck or knobbled bars shall be twice piled and rerolled. The wrought iron and the component parts of the bloom, slab pile, or box pile shall be free from any admixture of iron scrap or steel.

Definition of terms:

(a) Bloom: A bloom is a solid mass of iron that has been hammered into a convenient size for rolling.

(b) Slab Pile: A slab pile is built up wholly of flat bars of iron of the full length of the pile.

(c) Box Pile: A box pile is a pile, the outside of which is formed of flat bars and the interior of a number of small bars, all bars running the full length of the pile.

Chemical Properties and Tests:
Chemical Composition:

The iron shall conform to the following requirements as to chemical composition:

Manganese — Not over 0.06 percent

Check Analysis — An analysis may be made by the purchaser from a broken tension test specimen representing each lot as specified.

(b) Drilling for analysis shall be so taken as to represent the entire cross section of the specimen.

Physical Properties and Tests:
Tension Tests:

(a) The iron shall conform to the following requirements as to tensile properties:

Tensile strength bl. per sq. inch	47000 — 52000
Yield point, min. bl. per sq. inch	0.60 Tens. Str.
Elongation when measured in 8" min. percent	28
Elongation when measured in 4" min. percent	35
Reduction of area, min. percent	48

(b) The yield shall be determined by the drop of the beam or halt in the gauge of the testing machine. The speed of the crosshead of the machine shall not exceed ¾" per min. After passing the yield point the testing speed shall not exceed a maximum of 3 inches per minute.

(c) In calculating the tensile strength, yield point and reduction of area, the area of a 7/32" hole shall be deducted from the area of the bar.

Bend Tests

(a) Cold bend tests: The test specimen shall bend cold through 180 degrees flat on itself in both directions, without fracture on the outside of the bent portion.

. . . Dr. Greenslade then read his prepared paper ending with the first paragraph at top of page 34 in which Mr. W. C. Masters was introduced to present his comments. . . .

Comments by Mr. W. C. Masters

Dr. Greenslade has covered the subject of threads very carefully and should be commended for the work he has done.

In the National Screw Thread standardization which was started back in 1921, we started out to develop a thread standard under a report of Mr. Hoover's. First, we started on the thread size and form, and the tolerances. We were not successful until we first developed gauges and method of gauge control.

I would like to recommend to this Committee before this report is accepted that a committee be formed of men who are well aware of and familiar with this type of threading and with the mating of parts, to study and come before this convention next year with a report on gauging; also, the maintenance of gauges and maintenance of taps to hold the tolerances. It is evident from my traveling around railroad shops and noting the tolerances and forms the railroads are using today that one standard will mean a lot in keeping staybolts tight in the boilers and decreasing cost of maintenance of fireboxes. My object is to leave with you the thought of developing a committee which will give this subject considerable study in cooperation with Dr. Greenslade's report on Threads. I believe the Association and the railroads will be well-benefited by both of these studies.

Thank you. [Applause]

Chairman Greenslade: The next paper on the program is by Mr. S. E. Christopherson, vice chairman of the Committee for Topic No. 3. There are three additional papers which have been prepared by the remaining members of the Committee. (See Committee Report). I am now going to ask Mr. Christopherson if he will please take over the meeting and, after presenting his paper, take up the remaining papers in such detail as there may be time for, making due allowance for discussion from the floor. . . .

Mr. S. E. Christopherson: Mr. Chairman, Fellow Boilermakers and Guests: As your representative on this Topic No. 3, I wish that a vote of thanks be given to Dr. Greenslade, Messrs. Masters, and Fitzsimmons and the Flannery Bolt Company, and other members of the Committee, for the time and effort, and the splendid paper just read to you.

I have always believed that the Master Boilermakers in their trade, need a standard of this kind. When it comes before us again as a completed document at our meeting in 1948, it should be adopted as a Boiler Standard.

The report on the Topic from the various members of the Committee will not be read in full. Wish at this time to thank the members for their splendid co-operation.

Summarizing the parts of it which we believe is most beneficial, we find that the use of staybolts and firebox steel of approximately the same strength at the operating temperature, the use of overhead boiler checks for feed water, the use of 100% treated boiler water, the best machinery, and good workmanship will make a good tight firebox.

I now turn the topic over to the President for any discussion that may come before us. Mr. Longo the topic is yours.

President Longo: Thank you, Mr. Christopherson. Our time is getting short so I am not going to call on the other people who have papers on Staybolts but I am going to throw the topic open for discussion. I know that a lot of you men have got ideas about staybolts. I want you all to get up and express your views. I consider that the Topic is open for discussion. Does anyone have anything to say about staybolts? Does anyone have any questions to ask Dr. Greenslade?

DISCUSSION

Mr. Christopherson: Mr. Chairman, I would like to ask Mr. Graulty if the American Locomotive staybolt taps are ground or just cut.

Mr. Graulty: All of our taps, both for the rigid and flexible, are cut. We got away from the ground taps.

President Longo: I saw a movie actor just come in our room and he had on dark glasses. Would you mind getting up and introduce yourself? We don't recognize you.

Mr. Frank Yochem: I broke my glasses and I am in a hell of a fix. [Applause]

President Longo: This is our newly elected Life Member, fellows, Frank Yochem.

Have you got anything to say about staybolts, Frank?

Mr. Frank Yochem: (Missouri Pacific) Gentlemen, I am very happy to be here, I am still active, I haven't turned into a "white mule" even if I did retire and I am going to be with you until I die since this organization has made me an honorary member for life.

I have been listening with a great deal of interest to the discussion on staybolts. I think we have on the Missouri Pacific a very good method, in that we cut all staybolts on vertical machines at our Kansas City Shops and they are shipped out from there to the various points on the Railroad. We don't cut any bolts down to follow the taps, the fellows have got to tap the hole that the staybolts are furnished to fit. We have got old, worn-out bolt cutters around our shops, and boilermakers as a general rule, never did have good tools, they give them something that is worn out. You get a bolt cutter, the heads are loose and rattling, and when the bolt is being threaded it goes in like a snake, you try it and it is a little tight, you take a little bit more off; the other fellow can't get the bolts in, he has a different size tap. and he comes back and wants them a little looser, with the result that you have a large number of bolts in the holes that are rattling and then you wonder why you have got leaky staybolts.

Leaky staybolts are something like a wild woman, they are a necessary evil, the only way you can figure, that a fellow who has got leaky staybolts has got plenty of trouble.

I believe you should use hollow bolts. The fit we want is on the fire side. You've got the drilled bolt, you apply it from the fire side, you've got the threads partly worn out before the bolt enters the outside sheet. If you've got a hollow bolt you can apply it from the outside and when it contacts the inside sheet, all it has got to go through is the thickness of the sheet and enough of the bolt to drive. So, I think there is a lot of merit in the hollow staybolt and its application in the fire line of the side sheet especially. You are not distorting the thread on the fire side. You have a fellow with a motor running these bolts and it is a drilled bolt, if you want it spaced at seven inches, he is running that seven inches of thread through the fire

side before he hits or contacts the outside casing sheet and then you wonder why bolts are leaky. I think one of the contributory causes is that you have ruined your fit and thread in applying the bolt before you even cut it off to drive. A hollow bolt in the fire sheet, applied from the outside in, I believe, is going to eliminate some of the troubles you are experiencing with leaky staybolts.

I thank you. [Applause]

Mr. S. E. Christopherson: I know that we have that parade you are talking about, but with an up-to-date machine, and what Dr. Greenslade is trying to explain, we know that you can overcome your difficulties.

I believe sincerely, that with the Class 3 Fit, the right tolerance on taps and a good machine, even though you apply these staybolts with a high speed motor, from the inside or outside, you will have a better fitted bolt.

When you read some of the tolerance as given in this report, there is no wonder we have trouble; and this can only be overcome by adopting standard, as reported by Dr. Greenslade.

There in no one tap, nor is there a boilermaker, who can apply a staybolt with that much tolerance; nor can he ever keep it tight. [Applause].

President Longo: Thank you, Mr. Christopherson.

We have with us a fellow, one of our younger members, who has had quite a lot of experience on seal welding his bolts. He happens to be with my Railroad and I would like to have him come up here and tell of his experience with seal welding bolts and how he does it. Will you come up here, Mr. G. L. Downum, Southern Pacific R. R.

Mr. Downum (Southern Pacific Co.): Mr. President, Master Boiler Makers and Guests: We on the Southern Pacific have been seal welding staybolts for the past 18 months with very good results. We have used two different methods in seal welding staybolts on inside sidesheets of fireboxes. Our first method was used by running in the staybolts, cutting and driving in the usual manner, then seal welding, starting at the bottom of the staybolt head and making a continuous weld around the head of the staybolt.

A few months ago we discontinued driving the staybolts. We now cut the bolts to 2½ threads in length after the bolts have been driven, then mill off slag and threads from end of bolt, making sure to have good clean surface to weld to; using ⅛" welding rod, start at bottom of bolt, welding to top; after scale has been cleaned from each end of weld, start at bottom and weld other side of bolt. Tight staybolts are very necessary in order to eliminate one of the most important causes of checked and broken sidesheets. There is no doubt that seal welding will increase the service life of sidesheets. You people who are having trouble with sidesheets leaking, I think seal welding is the answer. We have had very good results with welding the bolts.

President Longo: We want to make a sketch of how he applies those bolts, fellows. He applies the bolts in the usual manner (draws sketch in illustration). He has a print here of a counter bore tool that trims the threads right off. The bolts are set at 2½ threads in the firebox side and this counter bore takes the threads right out and it leaves a smooth surface here for welding. The welding is built up with one pass starting at the bottom and going around to the top of the bolt, ending here (indicating on sketch).

They started welding those bolts in April, 1946. We were using the old method, as he was telling you, and we changed over to this method.

It is surprising that in our bad water districts we have not had a bit of leakage on any of our power and it has gone through the shop without having to change sidesheets. Heretofore our large power was being shopped every 11 or 12 months for the removal of sidesheets. We are running them through the shop now without taking out sidesheets due to the seal welding of bolts.

Mr. J. D. Johnson (Chief Boiler Inspector, Missouri Pacific R. R.): Does he drive those bolts after he welds them?

Mr. Downum: I drive them on the outside sheet first.

Mr. Johnson: How do you keep your bolt from getting loose in the hole after you run a bead around there?

Mr. Downum: We drive from the ouside sheet first, then we cut them off and remove thread, and then weld.

Mr. Johnson: We were contemplating something similar to that, however we figured on driving the bolt after the bolt was welded.

President Longo: His method is to apply the bolt from the firebox sheet because the tell-tale hole is drilled in the bolt before application to boiler. He sets the bolt at the usual length on the outside and before cutting the bolt off on the inside he drives the bolt on the outside. After the bolt is driven on the outside, then he burns the bolt off 2½ threads, then a counter boring tool is set on the bolt and centralized and he takes the thread off.

Mr. B. K. Leverette (Gen. Foreman Boilermaker, Southern Railway Co.): We have been welding bolts approximately the same as you do but we don't take the threads off. Do you use a coated wire?

Mr. Downum: Yes, sir.

Mr. Leverette: Have you done it long enough that you know whether or not you are going to have terminal defects?

Mr. Downum: Eighteen months, but it looks good.

Mr. Leverette: We have taken our sheets out in about 18 months. We run our bolts from the outside in. We first tried the bolts with 1½ threads, and they decided it wasn't enough head so then they boosted it up to 2½ threads. We used the shell side to get a few licks on the inside and then the sheet was sandblasted and then the welding of the bolt.

Mr. Downum: We have found that hammering the bolt on the inside sidesheet distorts the thread and by seal welding the bolts it is unnecessary to drive the bolts.

Mr. Leverette: When you drive your bolts do you loosen your bolts in the sheet?

Mr. Downum: No, sir. We have a good fit and we don't cut them until after the bolts are driven on the outside sidesheet.

Mr. Leverette: I feel you have some effect on that thread and probably loosen it up. That is the reason I asked that question.

Mr. Barrett: There is one thing in connection with the application of bolts, whether it is seal welded or whether it is driven by the conventional method, and that to my mind is most important and seldom touched on at these meetings, although Mr. Christopherson has mentioned it briefly in his paper, is that of driving of the bolts. I think most bolts today are driven by the

1947 method and held on by the 1847 method. You know from your experience as well as I do from mine that the helper with a "Holding-on dolly", gets tired very quickly, especially if it is not supported, and he is missing one out of every two or three blows of the pneumatic hammer with his tool, and this I think is the cause of much of our staybolt leaking. I believe whether you are going to seal weld your bolts or whether you are going to continue to drive them by the conventional method the double gunning is the proper way.

We have applied a number of seal welded sidesheets, making a test with, one side seal welded and the other side driven by the conventional method. So far we have not found the conventional side giving out. To our mind the success of the seal welded bolt will be proven when the other side gives out. We are trying this in the so-called good water district, which to my mind it is our bad water district. We have found in our soft water districts that the silica content of the water creates a condition which shortens the life of our firebox sheets so that to my mind the hard water districts are the best ones we have to deal with. It is in the soft water district with high silica content in which we are trying out these seal welded bolts. After eighteen months test the report is that they are giving satisfaction; that is, the other side has not given out yet.

In connection with the application, you have to hold on whichever way you drive the bolts. We use our bolts and these are applied from the outside with a 60-degree bevel which does away with the necessity of stripping off the threads at the inside sheet. If you bevel the end of your bolt that goes in the firebox side 60°, which is about 2½ threads, that plain part of the bolt will protrude through the sheet, and then in the holding-on process by the double gun or pneumatic hold-on you flatten that head sufficiently to form almost the diameter of the original bolt, and then after cleaning the sheet we seal weld them around. That to us so far has proven to be the most satisfactory method. [Applause]

S. E. Christopherson: Mr. Chairman, I think Mr. Barrett has the right idea, as in regard to driving the staybolts. This Topic has drifted over into seal-welding of staybolts. I have tried it and know the benefits of it. Seal-welding is not a cure-all. You still must do the best job on staybolting you know how. It is one of the best methods we have found to keep the staybolts and sidesheets in a healthy condition. Your mileage can be increased indefinitely depending on the job you do. As I have stated to you before in my reports on this Topic, we have tried, on the railroad I represent, practically everything.

In fact to prove seal-welding will help, a poor fitted staybolt job was picked out as a test, in order to find out how much service a poor fitted staybolt seal-welded would give us. You all know that a job of this kind would be an impossible task to keep tight.

The staybolts and sidesheets gave us good service; but of course, it is not the right way.

If you look back into the 1945 proceedings, you will find a picture showing a shallow rivet set, $\frac{1}{8}$" in depth, the diameter to suit the size of staybolt you use. For example, on a 1" staybolt, the set would be 1" in diameter and $\frac{1}{8}$" in depth, etc.

Mr. Barrett stated that this same set or die if used in a pneumatic combination of a riveter and holder-on or two #60 riveting hammers on double gunning, you would not have to use any other tool to finish the head of driven bolts.

The penetration of electrode used, will go deep enough to remove any

thread on the staybolts set for length to a driven head.

There must be no oil left on either staybolt or sheet for a permanent job.

President Longo: Gentlemen, I just want to say a word. This seems to be a live subject on everybody's Railroad and since we are short of time I am going to suggest that we leave one of these topics for tomorrow afternoon, but that will be up to you fellows. Topic No. 4 when we come to it we won't read the paper but we will go into a discussion of it. This seal welding and leaky bolts is a serious matter on everybody's Railroad and I would like to know whether you fellows would object if we just go ahead with this topic for the next few minutes. [No objection registered.]

Mr. Service: There is something on the seal welded staybolt that apparently I have either misunderstood or has not been brought out at this meeting and it is my understanding that we must have a tell tale hole in the seal welded end of each staybolt.

President Longo: No, absolutely not.

Mr. Service: The last data I have is in black and white received from my superior and that is the type application that we made. However, in order to give you the information of that application, we had one locomotive in service that had the seal welded staybolts applied 16 rows high above mud ring, approximately 365 staybolts in each side sheet. The right side of firebox had a certain type of staybolt material that I do no wish to mention further, however, the left side was equipped with our standard iron staybolt material. The staybolts started to fail adjacent to seal welded bead at head of staybolts at about 219,000 miles, however, at 215,628 miles locomotive was shopped and the locomotive had worked in a bad water district. When inspected, we found small cracks at several staybolt holes and stress lines between staybolt holes sufficient to cause removal of side sheets. However, we did secure a wonderful performance from the seal welded staybolts. Otherwise, we would have found it necessary to renew a lot of staybolts and patch the cracked side sheets.

I can say this, that same locomotive is again in service with seal welded staybolts on each side of firebox and we did have the tell tale holes applied in the fire or seal welded end. The seal welding of these staybolts was made by welder making one single bead of weld metal around staybolt welding each side of staybolt, starting at top and finishing at bottom, using type AWS electrode No. 7012, $\frac{1}{8}$" in diameter, and after each staybolt was seal welded a small drift pin, used in a No. 1 caulking hammer, was inserted in tell tale holes by welder and he gave four or five blows which would have a tendency to relieve any contraction stresses in seal weld around head of each staybolt.

Time will tell, of course, as to what success we will have or what the results will be.

Mr. E. E. Owens (Gen. Boiler Inspector, Union Pacific R. R.): A good many years ago a boiler maker foreman told me that he was seal welding staybolts before we even had permission to do it and I believe he mentioned it in this hall. I ran across another fellow who did it but he lost his job for doing it. Then we had permission to seal weld them and, as I understand it, if the bolts are applied in the conventional manner, tapped and driven, we are permitted to seal weld the bolts.

I welded bolts a year ago in April and I have engines that have made 250,000, some 260,000 miles. I have only had eight sets welded. I put my bolt in like Frank did, I set two threads at the end, the first set I drove with a shallow snap. Mr. Christopherson's method that he adopted. I held on

and just cupped the bolt like that (illustrates by blackboard sketch), then I welded it at this point, I only welded the bolts in the sidesheets. I got good results from that application but I had to renew 79 bolts on account of leakage in the sidesheets where the weld would break loose in spots an eighth to a quarter of an inch in circumference.

The next set of bolts we used were hollow bolts, we drove with a tit snap put the bolts tight in their holes let the air hammer run while driving outer end, double gunning you might say. I got a job something like that (draws sketch), with an opening in here possibly a thread.

Going back to that, we did bevel the end of our bolts about 45 degrees. That took off about a thread and a half. Then we seal-welded bolts, and went further on this set of bolts and welded every bolt in the firebox, crown stays and all. I got 258,000 miles to date on this engine and I haven't renewed any bolts on account of leakage, I thoroughly believe that it is necessary to drive your bolts when you are going to weld them. Another advantage to doing this, where you have a 23 B and you hold on with the flat or cup snap you have an awful job of opening up tell tale holes and reaming out these holes; with the center point snap it requires very little reaming to accommodate a porous cement plug.

The first thing is to get a good fit on your bolts, go over bolts with a hammer. The next thing is the cleanliness of the job. I sandblasted my sheets before I put them in. When you tap out holes, the oil will run down on the floor and all over the sheet, we washed it off with kerosene, gasoline, and everything else because we found that when you start to weld the bolt oil will come out, regardless of how tight your bolts are. Then I painted that whole sheet over with alcohol and whiting, painted it in the evening and the next morning started to weld my bolts, took a steel brush, brushed them off and the sheet looked like a silver dollar. I did not have very much oil, not enough to hurt them. I believe best method of welding is to start at top and weld down on all of your side bolts, a continuous weld all the way is OK for over head bolt.

On the first job we did I used straight polarity wire, I had a good many pin holes at the connection. The latter and all the other jobs are reverse polarity wire. We have steel bolts welded in Molybdenum sidesheets, that engine has something over 100,000 miles and has never given me any trouble; I have iron bolts welded in Molybdenum sidesheets, I have had no trouble with those, and I strongly advocate the seal welding of bolts. At 100,000 miles on our oil-burning engines we used to apply patches in the sidesheets on account of checks, over-working the staybolts, mushroomed heads. At 100,000 miles we bring that engine in now and she is good for another 100,000 miles, and I am even going on the third 100,000 miles with some of those engines.

I thank you. [Applause]

President Longo: When we can increase the life of our sidesheets we can compete with the Diesel engine.

Mr. Milligan (Canadian Pacific Ry.): Mr. Chairman, we have been seal welding staybolts since 1944 and we have not taken out a sheet that has been seal welded. Prior to seal welding them, particularly in the soft water district, as Mr. Barrett said, we would have trouble, with 30,000 to 50,000 miles they started to crack and it would be one mass of weld when we got into the back shop, we never got into a general repair without taking out the sidesheets. Now we are not bothering. We have several engines now on test, in fact, we are considering making a general application.

Mr. S. E. Christopherson: I think I can answer Mr. Service's question

on the reason for the tell-tale hole. When this subject of seal-welding staybolts was first brought before the Interstate Commerce Commission, a thought in their minds was that with the welding of staybolt to the sidesheets you would be unable to detect a broken staybolt by the sound or vibration on a hammer test, and that was the main reason for the recommended practice of using a hollow staybolt or the drilling of a tell-tale hole.

Mr. Service: That answers the question, however, the last instructions I have states that a tell tale hole is to be applied in seal welded end, and it came through the regular channels of the Chicago office and from Washington.

President Longo: The A.A.R. on the staybolt application showed the cut of a bolt with a tell-tale hole in it on the firebox side and that kind of confused us a little bit, but we went ahead and applied bolts in the usual manner without the tell-tale hole. Mr. John Hall has written us a letter and told us that as long as we were satisfied with welded staybolts it would not be necessary to receive permission to weld bolts, so I think we should all take advantage of that.

Mr. Service: This is one of the reasons we have been a bit backward in proceeding with seal welded staybolts. If we have to drill a tell tale hole in the opposite ends of every solid staybolt, it means added expense and money and that is one of the things that has been holding us back.

Mr. Christopherson: You don't have to.

President Longo: I don't know why you fellows should feel that you would have to drill a hole unless you got that from John Hall and I don't believe that he put out any information like that. I did not see any.

Are any of you other men concerned about seal welding of bolts?

Mr. James A. Bower (Gen. Boiler Inspector, Bessemer and Lake Erie R.R.): I would like to ask one question in regard to the caulking of bolts when hydrostatic pressure is applied. If I understand this correctly, on a welded staybolt you are not permitted to caulk.

President Longo: No. You can caulk all you want to but you can't reweld that bolt, can't chip part of it off and reweld it; you must remove the bolt and reapply it.

Mr. Gilley: Frank Yochem asked a lot of $64 questions and I would like to make a $64 suggestion. Why should it be necessary to seal weld staybolts except when you have a high silica content water? What we should get after instead of seal welding staybolts is to get our chemical engineer to whip the silica scale. That is what we want.

President Longo: I agree with you, that is a good thought, but it costs an awful lot of money to do that and I'll tell you if we waited for that we would never get to first base.

Mr. France: Mr. Chairman, are there any manufacturers of stationary boilers here that are putting in staybolts on high pressure boilers that don't put any threads on the staybolts? I know there are staybolts being put in without any threads at all. The Southern Pacific man talked about taking the threads off the bolt, Mr. Christopherson said he took threads off the bolt. If that is the case, why put threads on the bolt?

Mr. Christopherson: The thread is still in the hole, don't forget. We are talking about the outside part of that thread, not what is in the hole.

Mr. F. P. Huston (The International Nickel Co., Inc.): It is mighty good to see the progress being made in the seal welding of staybolts.