

Ref 5

MAR 31 1981

Docket No. 50-410

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MEMORANDUM FOR: Robert L. Tedesco, Assistant Director
for Licensing
Division of Licensing

FROM: James P. Knight, Assistant Director
for Components and Structures Engineering
Division of Engineering

SUBJECT: DYWIDAG THREADBAR SYSTEM FOR SPLICING OF REINFORCING
STEEL BARS - NINE MILE POINT 2

Plant Name: Nine Mile Point 2
 Docket No.: 50-410
 Licensing Stage: Post CP
 Responsible Branch: Licensing Branch 1
 Responsible Project Manager: Kenneth L. Kiper
 Description of Task: Review of DYWIDAG Threadbar System for Splicing
of Steel Bars
 Review Status: Completed

- Reference: 1. Meeting between NRC staff and representatives of Niagara
Mohawk Power Corporation (NMPC), Stone & Webster, and
Dyckerhoff & Widmann, Inc.
2. Letter from Donald P. Dise of NMPC to B. J. Youngblood
of NRC, dated March 18, 1981.

Based on the discussions in the above referenced meeting and the review
of the information provided by the applicant in subsequent letter
(Reference 2), we find the conditional use of DYWIDAG threadbar system
for splicing of reinforcing steel bars acceptable. The conditions and
limitations on the use of this system were discussed in the meeting and
the applicant has made a commitment to comply with them in Reference 2.
These conditions and limitations are as follows:

1. Compliance with the applicable provisions of Section III, Division 2
of ASME Boiler and Pressure Vessel Code, 1980 Edition, including the
Summer 1980 addenda;
2. Compliance with the applicable provisions of Section 7.5 and 7.6 of
ACI 349-76 Code, "Code Requirements for Nuclear Safety Related
Concrete Structures".

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Additionally, unstaggered applications are subject to the limitations and conditions described below:

1. Compliance with the above referenced codes.
2. Limited to bar sizes #6 thru #11
3. Limited to doweling at junctions between secondary containment wall and slabs of reactor building.

We find that the statistical summaries of strain data for bar sizes #6 thru #11 at the strain levels corresponding to 50% and 90% of yield stress are acceptable. The applicant has also provided some typical calculations indicating that the stress levels under all applicable load combinations are below 50% of the specified yield stress of the bar at the locations indicated in item 3 above. In addition, the criterion proposed by the applicant, for minimum clear distance between parallel splices, is also acceptable.

We have reconsidered our requirement regarding tensile test data for group of unstaggered spliced bars because of the applicants modified request of limited use and the technical arguments (including analytically simulated data on group behavior) presented in the meeting. Considering the stress levels and stress-strain curves provided by the applicant, we have determined that at low stress levels there is no significant difference between unspliced and spliced bar. We suggest that for this application the requirement of the tensile test data be waived.

Thus, we recommend to approve the use of this system at Nine Mile Point 2 subject to above conditions without any further requirements.

During our discussions at the meeting we also learned that the reinforcement requirements at the location indicated earlier were based on the use of Grade 40 bars. However, the applicant plans to use Grade 60 thread bars for this application. The use of the same amount of reinforcement of higher strength may necessitate the rechecking of the reinforcement ratio requirements of Section 10.3 of ACI 318-77 Code. The applicant should be directed to carry out such an evaluation and provide the documentation for our review.

James P. Knight, Assistant Director
for Components and Structures Engineering
Division of Engineering

cc: R. Vollmer
F. Schauer
B. Youngblood
D. Jeng
K. Kiper

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INSTALLATION PROCEDURE FOR THE
DYWIDAG THREADBAR REINFORCING STEEL SYSTEM

1. General Requirements

Upon receiving, threadbars and accessories shall be checked for proper size and material identification. Couplers and nuts as well as all equipment shall be stored in a clean, dry area protected from rain, snow, standing ground water and dirt. Reinforcing steel threadbars and plates may be stored outside on wooden blocking to prevent contact with standing ground water. For prolonged storage the threadbar bundles and/or plates shall be covered with plastic or tarpaulin canvas.

Before starting fabrication of the threadbars and splice installation the person or persons in charge for these operations shall make themselves familiar with the instructions given in this chapter and any applicable supplementary instruction and shall advise their personnel accordingly. A Field Supervisor of Dyckerhoff & Widmann may be assigned to assist that all work is properly performed. A copy of these instructions and any supplementary instructions as well as a description and calibration charts of the applicable equipment shall be kept on the jobsite.

2. Threadbar Fabrication Procedure

In general DYWIDAG Threadbars can be fabricated like any other type of reinforcing steel bar conforming to the ASTM Specification A 615 according to regular fabrication instructions as, for example, the CRSI Manual of Standard Practice. However, for bar ends to be spliced with a threaded coupler special instructions apply as follows:

Bending: The spliced ends of curved bars have to be straight and shall not be bent. The length of the straight section on the spliced bar end shall be at least equal to the length of the coupler plus the lock nut, if used, as designated for that size and grade of threadbar.

L/IF

Cutting: Bar ends shall be cut nominally square. The deviation of the plane of the cut surface from "square" shall not exceed 1/8 inch. DYWIDAG reinforcing steel threadbar may be cut by abrasive wheel, band saw or by oxygen torch. Burrs at the cut ends may be removed by grinding as needed to allow engagement of the coupler and/or nut. The thread deformations on the bar shall not be damaged during cutting and grinding. Damages to the first rib deformation next to the bar end are acceptable as it has to transfer only a small residual portion of the working load.

For splices in compression without lock nuts, saw cutting is required. The deviation of the cut end from a 90 degree angle to the bar axis may not be more than 1 1/2 degree.

3. Control for Bar Thread Acceptability

On bar ends to be spliced the bar thread acceptability shall be verified. One criterion for an acceptable thread is that a standard coupler designated for that bar size and grade of steel can be screwed on the bar end. This test coupler is selected from a lot of regular couplers such that its inner diameter will be one of the lowest in the lot. One test coupler shall not be used for more than 200 threadability tests. In case the bar fails the test, it shall be rejected for use in combination with couplers.

The second criterion for an acceptable thread is sufficient rib height, that is a sufficient diameter of the bar measured across the top of the ribs. A "No Go" gauge in the form of a "U" shaped piece of steel for the designated bar size and grade of steel shall be used for this dimensional check. In case this "U" shaped template can be fitted over the bar across the top of the ribs, the bar shall be rejected for use in combination with couplers.

Bars failing to meet either one or both of the criteria described above may still be used as regular reinforcing bar, however, not in combination with couplers. They shall be specially marked with a tag: "Not for splicing".

The thread acceptability tests will be performed on both ends of the first 10 bars of a lot or heat. In case they all pass the tests it will be sufficient to check 20 % of the rest of the bar ends with the "U" shaped No Go gauge only. When one bar is encountered that evidences a too small diameter across the top of the ribs, 100 % of the lot shall be checked with the "U" shaped gauge.

4. Control of Couplers and Nuts

Couplers, nuts and plates have been subject to quality control already before shipping to the jobsite. At his discretion, the Inspector may check at random if the outside dimensions are within the specified tolerances. Ends of nuts and couplers may be checked for squareness. A Go-No Go gauge may be used to control at random the inside diameter of nuts and couplers.

5. Splicing Procedure

Cleaning: The bar ends to be engaged in couplers and/or nuts shall be cleaned, using rags or wire brushes, from loose rust and scale to the extent necessary to screw a coupler or nut onto the bar. As long as the bar ends are threadable surface rust, any paint, dust or moisture will not affect the performance of the splice.

Marking: The ends of threadbars to be spliced shall be marked by painting or other suitable marker in such a way as to clearly demonstrate that the coupler is engaged for an equal length on both bar ends.

For splices without lock nuts the paint marks shall be applied at a distance from the bar end equal to one half inch plus half the length of the coupler as designated for that size and that grade of threadbar.

For splices with lock nuts the paint marks shall be applied at a distance from the bar end equal to one half inch plus half the length of the coupler plus the length of the lock nut, both as designated for that size and that grade of threadbar.

The paint mark shall be 1/8 to 1/4 inch wide and may be applied using a template for foolproof marking. The length of the paint mark shall be such that it will be clearly visible and accessible for measuring after torquing, but at least equal to one third of the bar circumference. The paint mark shall be applied with a $\pm 1/8$ inch tolerance. All measurements shall apply to the center of the paint mark. A type of paint resistant to abrasions and water shall be used. If, by accident, paint marks were applied wrong, they shall be removed completely to avoid mistakes later during assembly.

Splicing: a) Splices without lock nuts: The marked bar ends shall be engaged in the coupler for a length equal to half the coupler length with a tolerance of $\pm 1/2$ inch and until the engaged bar ends are butted. This may be accomplished either by threading both bar ends into the coupler for half the coupler length, or by first screwing the coupler for its entire length onto one bar end, butting the two bar ends together and then threading the coupler back onto the adjoining bar for a length equal to half the coupler length.

- b) Splices with lock nuts: The lock nuts shall be threaded onto the marked bar ends far enough to allow engagement of the coupler. The bar ends then shall be threaded into the couplers for a length equal to half the coupler length with a tolerance of $\pm 1/2$ inch and until the two bar ends are butted. This may be accomplished either by threading both bar ends into the coupler for half the coupler length, or by first screwing the coupler for its entire length onto one bar end, butting the two bar ends together and then threading the coupler back onto the adjoining bar for a length equal to half the coupler length. Once the coupler is correctly engaged on both bar ends the lock nuts are tightened against each side of the coupler.

Torquing: The slack between the two spliced bars within the coupler shall be removed by torquing. Torquing is also required for locking the coupler in position to prevent loosening of the splice.

If lock nuts are used they shall be torqued against the coupler with the amount of torque designated for that size and that grade of threadbar. The torque may be applied to one nut at a time, or to both nuts at the same time. If no lock nuts are used the two bars shall be torqued against each other with the amount of torque designated for that size and that grade of threadbar.

Torque requirements for DYWIDAG Threadbar Splices:

Bar Designation	Torque Moment (ft lbs)
6	300
7	400
8	500
9	600
10	800
11	1500
14	3000
18	6500

The torque moment shall be applied with a calibrated torque wrench, of sufficient capacity or with a special hydraulic torque tool. The torque wrench either may have a dial indicating the applied amount of torque, or may be of the type where an audible click indicates that the preset required torque has been reached, or it may be of another type that can reliably control the amount of torque introduced into the splice. For the hydraulic torque tool a pressure gauge will indicate the amount of torque introduced. A calibration chart shall accompany the equipment relating the gauge pressure to the torque output including range of tolerances. The operating instructions for the torque tool shall be followed.

The torque designated for a bar size and grade of steel shall be applied with a tolerance of minus 0 % and plus 40 %.

6. Final Splice Examination:

The correct engagement of the bar ends in the coupler shall be checked by measuring the distance of the color mark to the adjacent face of the coupler or lock nut, if used. The bar ends are sufficiently engaged when the full width of the paint mark is visible and/or the distance of the center of the paint mark from the face of the coupler, or lock nut if used, does not exceed 3/4 inch .

The amount of torque may be checked by reapplying the torque tool or wrench.

Components of the Dywidag Threadbar reinforcing system are manufactured in the United States exclusively by Dyckerhoff & Widmann, Inc.

Grade 60 Dywidag Threadbar reinforcing steel is available in sizes in #6 through #18. Dywidag Threadbars conform to the requirements of ASTM A 615-75 except in markings. Dywidag reinforcing steel has a continuous rolled-in pattern of threadlike deformations along its entire length.

More durable than machined threads, the deformations allow nuts and couplers to thread onto the threadbar at any point along its length. Dywidag Threadbars may be shipped to the job site in 40 foot or 60 foot mill lengths or fabricated to specifications.

Dywidag hex nuts and couplers develop 125% of the guaranteed yield strength of the Dywidag Threadbar. Slippage of the Dywidag coupler under stress is controlled by torquing opposing threadbars together or by using lock nuts or hex nuts. The magnitude of the torque required varies with the allowable slip and threadbar size.

The Dywidag Threadbar reinforcing system offers a simple, reliable and economical splice. A Dywidag splice requires less crane time and less labor time for assembly than is required for welded or swaged splices.

Unlike some splices, the Dywidag splice may be installed in adverse weather conditions and does not create a fire hazard. As opposing threadbars need only be chalk marked before assembly to assure proper engagement, supervision and quality control requirements are minimized.

Coupler

When opposing threadbars are torqued together, the Dywidag coupler may be used without nuts. The splice will develop a 75 ksi tension stress or a 90 ksi compression stress in the Dywidag Threadbars.

Coupler with Hex Nuts

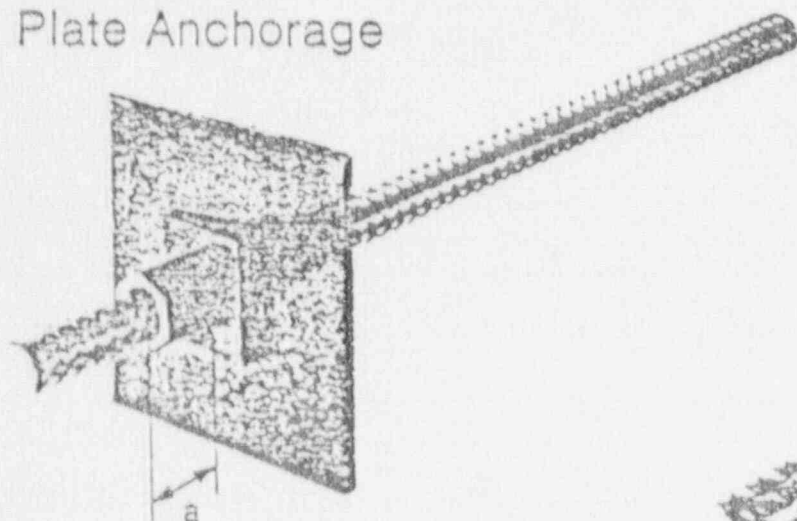
When opposing threadbars are not torqued together, hex nuts may be used with the Dywidag coupler. The splice will develop a 75 ksi tension stress or a 75 ksi compression stress in the Dywidag Threadbars.

Coupler with Lock Nuts

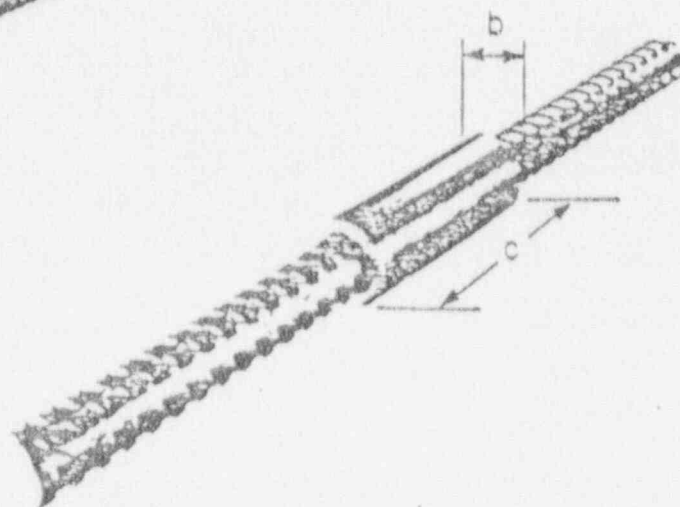
When opposing threadbars are not torqued together, lock nuts may be used with the Dywidag coupler. The splice will develop a 75 ksi tension stress or a 37.5 ksi compression stress in the Dywidag Threadbars.

Properly sawed or sheared, Dywidag Threadbars do not require end preparation except where the coupler is utilized without nuts as a splice carrying both compression and tension stresses.

Plate Anchorage



Coupler



Reinforcing steel properties†—ASTM A 615-75 (Grade 60)

Threadbar Size Designation	Nominal Threadbar Diameter (inches)	Yield Stress (f_y , ksi)	Cross Section Area (A_s , inches ²)	Yield Strength ($f_y A_s$, kips)	Weight (lbs./ft.)	Maximum Threadbar Diameter (inches)
#6	0.750	60	0.44	26.4	1.502	13/16
#7	0.875	60	0.60	36.0	2.044	1
#8	1.000	60	0.79	47.4	2.670	1 1/8
#9	1.128	60	1.00	60.0	3.400	1 1/8
#10	1.270	60	1.27	76.2	4.303	1 3/8
#11	1.410	60	1.56	93.6	5.313	1 3/8
#14	1.693	60	2.25	135.0	7.65	1 7/8
#18	2.257	60	4.00	240.0	13.60	2 1/2

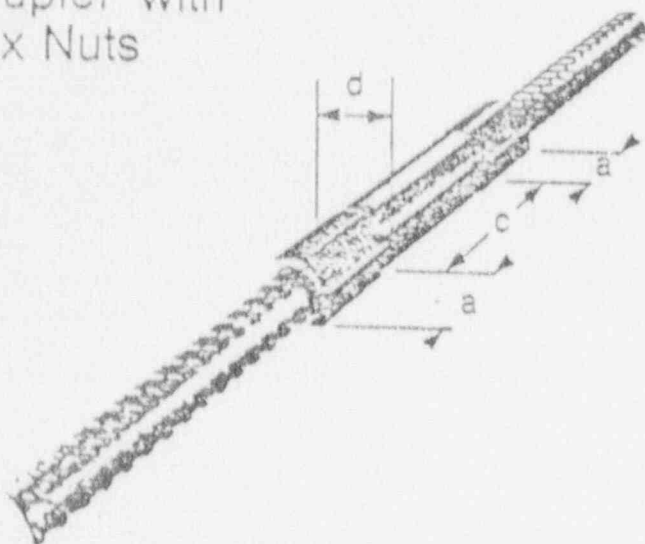
† Left hand thread for size #6 thru #11 and right hand thread for #14 and #18.

Reinforcing steel coupler and nut data*

Threadbar Size Designation	Coupler		Hex Nut		Lock Nut	
	Diameter b (inches)	Length c (inches)	Width d (inches)	Length a (inches)	Width d (inches)	Length e (inches)
#6	1 1/8	3 1/2	1 1/8	1	1 1/8	1 1/2
#7	1 1/4	3 3/4	1 1/4	1 1/4	1 1/4	5/8
#8	1 1/2	4	1 1/2	1 3/8	1 3/8	5/8
#9	1 5/8	4 1/4	1 5/8	1 5/8	1 5/8	3/4
#10	1 3/4	5	1 3/4	1 7/8	1 3/4	7/8
#11	2 1/8	6	2	2	2	1
#14	2 3/4	7 1/2	2 1/2	3 1/2	2 1/2	1 1/2
#18	3 1/2	10	3 1/4	4	3 1/4	2

* Coupler and hex nuts for #14 and #18 develop 100% of the guaranteed ultimate strength.

Coupler with Hex Nuts



Coupler with Lock Nuts

