Software Release Notice
Developed or Modified Software

1. Software Name: 3DStress®

Software Version: 3.1

2. Software Function: 3DStress is a stress analysis and visualization program for analysis of geological structures such as the fault and fracture in three dimensional stress fields.

3. Summary of Actions:
❑ New Software ■ Update to Existing Software ❑ Software Retirement

4. Software Development

4a. Software Requirements Description (SRD) Date Approved: July, 2002
4b. Software Development Plan (SDP) Date Approved: January, 2003
4c. Software Change Report (SCR) Nos: 532, 533, 534, 535, 536 and 601
4d. User's Guide Approval Date: (v.3.0) 8/2003
4e. Enclosed: ■ Copy of Program Title Block ■ Sample Source Code Header Block

Installation Performed by: [signature]
Date: 8/25/05

Remarks:

5. Software Installation

5a. Computer Platform(s): Sun (Microsystems SunFire V880Z server)
5b. Operating System(s): Solaris 9
5c. Programming Language(s): C++

5d. Installation Testing: ☑ Passed Testing Performed on: SunBlade 1500
Description of Testing Performed: App installed help loaded

5e. Archive Copy: ☑ Enclosed ❑ Not Available, Why:

Installation Performed by:: [signature]
Date: 8-25-05

Remarks:

6. Software Assessment

6a. Acceptance Testing:
❑ Enclosed ❑ Documented in Scientific Notebook No. ______
■ Documented in SCRs (see above) (see Validation Report)

6b. Validation Status:
❑ Full Validation ■ Limited Validation Date of Validation: August 2005
❑ Not Validated, Explain:

Software Developer: Nathan Franklin [signature]
Date: 8/25/05

Remarks:

7. Approval

Manager: [signature]
Date 8/25/05

Remarks:

7. QA Verification

SRN Number: 371

Software Custodian [signature]
Date: 8/25/2005

Remarks:

TOP–6–2 (12/2004)

Appendix A: Copy of Program Title Block (main.cpp)

```
// -----------------------------------------------------------------
// header info
// -----------------------------------------------------------------
// Program Name:     3DStress version 3.1
// Client Name:      U.S. Nuclear Regulatory Commission
// Client Division:  Office of Nuclear Material Safety and Safeguards
// Contract Reference: NRC-02-02-012
// CNWRA Project #:   20.06002.01.294 and 20.OHD20.124
// -----------------------------------------------------------------


#include "../src/mainWindow.h"
#include "../src/splash.h"
#include "tds.h"
#include "../../images/splash.xpm"
#include "../../images/logo_small.xpm"


#include<qapplication.h>
/*! \mainpage 3DStress Development Files and Documentation
 * \section intro Introduction
 *
 * This is the development pages and documentation for 3DStress Version 3.1.
 *
 * \section info Information, Copyright, and Disclaimer
 *
 *
 *
 *  Center for Nuclear Waste Regulatory Analyses (CNWRA),
 *  Southwest Research Institute (SwRI),
 *  San Antonio, Texas, USA.
 *  CNWRA Contact: David Ferrill (210) 522-6082
 *                 and Nathan Franklin (210) 522 5207
 *
 *  Customer Info:
 *   Name:  U.S. Nuclear Regulatory Commission
 *   Office/Division:  Office of Nuclear Material Safety and
 *                Safeguards
 *   Contact:  Philip Justus
 *   Phone #:  (301)415-6745
 *
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 *
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 *
 *  This program was developed under sponsorship of the U.S.
 *  Nuclear Regulatory Commission, contract number NRC-02-02-012.
 *  NRC Office of Nuclear Material Safety and Safeguards
 *  NRC Division of Waste Management, Engineering and Geoscience Branch
 *
 *  This computer code/material was prepared as an account of work
 *  performed by the Center for Nuclear Waste Regulatory Analyses (CNWRA)
 *  for the Division of Waste Management of the Nuclear Regulatory
 *  Commission (NRC), an independent agency of the United States
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 *  usefulness of any information, apparatus, product or process
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 *  BEING RENDERED INACCURATE OR LOSSES SUSTAINED BY THIRD PARTIES OR A
 *  FAILURE OF THE PROGRAM TO OPERATE WITH OTHER PROGRAMS) THE PROGRAM,
 *  EVEN IF YOU HAVE BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES,
 *  OR FOR ANY CLAIM BY ANY OTHER PARTY.


*/




int main( int argc, char **argv )
{
	QApplication app( argc, argv );

	QPixmap TdsPixmap = QPixmap((const char**)logo_small);
	QPixmap pixmap((const char**)splash_xpm);

	#ifdef SPLASH
	app.processEvents();
	Splash *splash = new Splash(pixmap, true);
	app.processEvents();
	splash->show();
	app.processEvents();
	#endif

	MainWindow *w = new MainWindow();
	app.processEvents();

	#ifdef SPLASH
	QWidget::connect(w, SIGNAL(status(const QString &)) , splash, SLOT(setStatus(const QString &)));
	QWidget::connect(w, SIGNAL(progress(int)) , splash, SLOT(setProgressValue(int)));
	#endif

	w->setIcon(TdsPixmap);
	w->setCaption("3DStress");
	w->setIconText("3DStress");

	w->init();
	app.processEvents();

	app.setMainWidget(w);
	w->showMaximized();
	app.connect( &app, SIGNAL(lastWindowClosed()), &app, SLOT(quit()) );


	#ifdef SPLASH
	splash->hide();
	delete splash;
	#endif

	return (app.exec());
}
```

SOFTWARE VALIDATION PLAN AND REPORT
3DStress® Version 3.1

Prepared for

U.S. Nuclear Regulatory Commission
Contract NRC–02–02–012

Prepared by

Nathan Franklin
Alan Morris

Center for Nuclear Waste Regulatory Analyses
San Antonio, Texas

August 2005

Approved by:

[signature]

John A. Stamatakos, Manager
Geology and Geophysics

8/23/05
Date

CONTENTS

1 SCOPE OF THE VALIDATION

This document is the Software Validation Test Plan and Report for the validation of the functionality of the code 3DStress® Version 3.1. Version 3.1 contains changes to problems in Version 3.0. Descriptions of the problems, changes, and acceptance tests are recorded in Software Change Report Numbers 532, 533, 534, 535, 536, and 601, attached to this report. 3DStress is an interactive, graphically oriented, user-friendly software application that computes the tendency for faults and fractures to slip, dilate, or leak. Faults and fractures are inputted as 2D trace maps, 3D cutoff lines, or as 3D surfaces. Faults and fractures displayed by 3DStress are colored based on the computed slip tendency, dilation tendency, or leakage factor. This is a limited validation which tests the calculation of slip tendency, dilation tendency, and leakage factor in single stress mode, vertical variation stress mode, and 3D stress mode. The validation also tests calculations displayed in the tendency plot, the loading of fault data, and analysis using a rose diagram.

2 REFERENCES

Ramsay, J.G. *Folding and Fracturing of Rock*. McGraw-Hill. 1967.
Software Development Plan for 3DStress, January 2003.
Software Requirements Description, 3DStress Version 2, July 2001.
Software Change Report Nos. 532, 533, 534, 535, 536, and 601.

3 ENVIRONMENT

3DStress Version 3.1 runs on a Sun workstation running the Solaris operating system. The following software items are required to perform the testing activities:

(i) 3DStress Version 3.1 software
(ii) Sun workstation with Solaris 9
(iii) Microsoft® Excel
(iv) Calculator

3.1 Hardware

3DStress runs on a Sun Microsystems workstation; it was installed on the Sun Microsystems SunFire V880Z server, Solaris 9. The application does not communicate or interface with any other computer system or software application. Input information is from existing data files or user input. Output information is saved on the computer hard drives. No peripherals (e.g., tape drives, printers, plotters) are necessary to execute the tests.

4 PREREQUISITES

None.

5 ASSUMPTIONS AND CONSTRAINTS

The user is assumed to be familiar with structural geology, the UNIX operating system, the Microsoft Excel software and 3DStress.

6 TEST CASES

3DStress utilizes user defined stress fields to compute the likelihood of faults or fractures to slip or fractures to dilate and leak. Faults and fractures displayed by 3DStress are colored based on the computed slip tendency, dilation tendency, or leakage factor. Slip tendency is the ratio of the shear stress to the normal stress on a fault surface. Dilation tendency is the likelihood for a fault or extension fracture to dilate based on the three-dimensional (3D) stress conditions and is computed from the normal stress and the principal stresses. Leakage factor is similar to dilation tendency, but takes into account any available information on fluid pressure and tensile strength of fault-zone or fracture-filling material. The input 3D stress orientations and magnitudes may be interactively modified through a user interface. We performed the following test to assess: (i) the correct calculation of slip tendency, dilation tendency, and leakage factor in single stress mode, vertical variation stress mode, and a 3D stress mode; (ii) the use of a rose diagram; and (iii) the plot tool. Tests were performed from manual input, as well as loaded fault data.

6.1 Test 1: Modification of a Single Stress Field

6.1.1 Objectives

Verify that user can modify the stress field by using the slider bars and by entering values. If invalid data are entered, verify that the user is warned of any problems. Also, verify that data files can be saved and loaded. If incorrect data files are loaded, verify that the user is warned of any problems.

6.1.2 Test Input

"NormalValues.mag"
100 50 5
0 90
0 0
90 0
0.01 -0.01
0

6.1.3 Test Procedure

Protocol:

a. Open the Stress display.
b. Under Stress Field Type, select Single Stress Tensor.
c. Enter a set of magnitudes and orientations for the three principal axes by using the slider bars and input fields. Verify your desired selections by comparing those with the ones that are displayed in the Plot window.

u = 80 Mpa	u direction = 236	u plunge = 57
v = 20 Mpa	v direction = 056	v plunge = 33
w = 35 Mpa	w direction = 146	w plunge = 0

d. Save this stress tensor to a file.
e. Alter the magnitudes of the principal stresses and orientations of the three principal axes by using the slider bars as input fields.
f. Load and verify that stress tensor was correctly loaded from the NormalValues.mag file.
g. Input large numbers (e.g., >360° for directions and >90° for plunges), small numbers (e.g., <−90° for plunge or <0° for direction), and/or text for the direction or plunge of the principal axes using the input fields. Verify that the software warns the user of improper input.
h. Input extremely large numbers (2e5) and/or text for the magnitudes of the principal axes using the input fields. Verify that the software warns the user of improper input.

6.1.4 Success Criteria

All the procedures should be performed and their results verified for success.
Verified.

6.2 Test 2: Slip Tendency Calculation and the Display of a Fault Orientation in the Plot Window

6.2.1 Objectives

Verify that the user can modify the stress field by using the slider bars and by entering values. Verify that the user can input and display the fault orientation in the Tendency Plot window. Verify the accuracy of fault orientation in the legend.

6.2.2 Test Input

None.

6.2.3 Test Procedure

Protocol:

a. Open the Stress display.
b. Under Stress Field Type, select Single Stress Tensor.
c. Enter a set of magnitudes and orientations for the three principal axes by using the slider bars and input fields. Verify your desired selections by comparing those with the ones that are displayed in the Tendency Plot window.

Inputs:

u = 74 Mpa	u direction = 072	u plunge = 90
v = 47 Mpa	v direction = 072	v plunge = 0
w = 25 Mpa	w direction = 162	w plunge = 0

d. Enter another set of magnitudes and orientations for the three principal axes by using the slider bars and input fields. Verify your desired selections by comparing those with the ones that are displayed in the Tendency Plot window.

Inputs:

u = 91 Mpa	u direction = 252	u plunge = 65
v = 17 Mpa	v direction = 072	v plunge = 25
w = 50 Mpa	w direction = 162	w plunge = 0

e. In the Slip Tendency Plot window, use left or middle mouse button to drag the normal to the fault plane (white square) to a new location.
f. Does the Slip Tendency legend accurately reflect the strike and dip of the fault?
g. Arbitrarily select a plane in the Slip Tendency Plot with your mouse and complete the following steps (h–p) or use the Excel spreadsheet "3DStress.xls":

Selected Plane

Inputs:

strike = 109.9
dip = 045.1

h. Compute direction cosines (with respect to +X = east, +Y = north, +Z = up) for each of the three principal stresses:

a = cos(angle between principal stress direction and east)
= cos(Plunge) x cos(Azimuth)

b = cos(angle between principal stress direction and north)
= cos(Plunge) x cos(Azimuth - 270)

c = cos(angle between principal stress direction and up)
= cos(90 + Plunge)

Calculated:

$\sigma 1$	$\sigma 2$	$\sigma 3$
a = −.130596225	a = −.951056516	a = 0.280064508
b = 0.401933852	b = −.309016994	b = −0.861949927
c = −0.906307787	c = 6.125744e-17	c = −0.422618262

i. For the arbitrary plane and using the right hand rule, determine the pole to this plane.

The pole to this plane has the orientation:

Azimuth = Strike − 90
If Azimuth <0 then Azimuth = 360 + Strike − 90

Plunge = 90 - Dip

Calculated:

Azimuth = 19.9
Plunge = 44.9

j. Compute direction cosines (with respect to +X = east, +Y = north, +Z = up) of pole to arbitrary plane.:

a = cos(angle between pole to arbitrary plane and east)
a = cos(Plunge) x cos(Azimuth)

b = cos(angle between principal stress direction and north)
b = cos(Plunge) x cos(Azimuth − 270)

c = cos(angle between principal stress direction and up)
c = cos(90 + Plunge)

Calculated:

Pole to Arbitrary Plane:

$a_A = 0.666043539$
$b_A = -0.241104395$
$c_A = -0.705871571$

k. Compute direction cosines of pole to arbitrary plane with respect to principal coordinates. The angle, θ, between vector A (with direction cosines a_A, b_A, c_A) and vector σ_i (with direction cosines $a_{\sigma i}$, $b_{\sigma i}$, $c_{\sigma i}$) is given by:

$$\theta_i = 2 \times \sin^{-1} \frac{\sqrt{(a_A - a_{\sigma_i})^2 + (b_A - b_{\sigma_i})^2 + (c_A - c_{\sigma_i})^2}}{2} \qquad \text{(Pythagoras)}$$

Calculated:

a (direction cosine of pole to arbitrary plane with respect to σ1) = cos θ_1 = 0.455846
b (direction cosine of pole to arbitrary plane with respect to σ2) = cos θ_2 = −0.55894
c (direction cosine of pole to arbitrary plane with respect to σ3) = cos θ_3 = 0.692669

l. Substitute values of principal stresses and direction cosines into equations for normal (σ) and shear (τ) stress on an arbitrarily oriented surface within a stress tensor (e.g., Ramsay, J. G., 1967. Folding and Fracturing of Rocks, McGraw-Hill, pages 35 and 36).

$$\sigma = \sigma_1 a^2 + \sigma_2 b^2 + \sigma_3 c^2 = 42.687$$

$$\tau = \sqrt{(\sigma_1 - \sigma_2)^2 a^2 b^2 + (\sigma_2 - \sigma_3)^2 b^2 c^2 + (\sigma_3 - \sigma_1)^2 c^2 a^2} = 28.606$$

m. Verify that the values for shear and normal stress calculated in Steps a through l or using the Excel spreadsheet "3DStress.xls" match those given by 3DStress and displayed in the Tendency Plot window.

Stress Tensor:

u = 91 Mpa	u direction = 252	u plunge = 65
v = 17 Mpa	v direction = 72	v plunge = 25
w = 50 Mpa	w direction = 162	w plunge = 0

Strike, Dip and Pole to Arbitrary Plane:

Plane:
Strike = 109.9
Dip = 45.1

Pole:
Azimuth = 19.9
Plunge = 44.9

Values Calculated Here:

σ_N (Normal Stress) = 42.6865 Mpa
t (Shear Stress) = 28.6061 Mpa

Values Calculated and Displayed in Tendency Plot Window:

σ_N (Normal Stress) = 42.701 Mpa
t (Shear Stress) = 28.612 Mpa

n. Verify that the slip tendency value calculated here matches the value calculated by 3DStress and displayed in the Tendency Plot Window.

Values Calculated Here:

Slip tendency = t / σ_N = 0.670144

Values Calculated and Displayed in Tendency Plot Window:

Slip tendency = t / σ_N = 0.670

Does the color beneath the normal to the fault (white square) match the legend color for this slip tendency?
Yes

o. Verify that the dilation tendency value calculated here matches the value calculated by 3DStress and displayed in the Tendency Plot Window. To calculate dilation tendency, select dilation tendency in the 3DStress Options dialog.

Values Calculated Here:

Dilation tendency = $(\sigma_1 - \sigma_N) / (\sigma_1 - \sigma_3)$ = .652885

Values Calculated and Displayed in Tendency Plot Window:

Dilation tendency = $(\sigma_1 - \sigma_N) / (\sigma_1 - \sigma_3)$ = .653

Does the color beneath the normal to the fault (white square) match the legend color for this dilation tendency?
Yes

p. Verify that the leakage factor value calculated here matches the value calculated by 3DStress and displayed in the Tendency Plot Window. To calculate leakage factor, select leakage factor in the 3DStress Options dialog and select a tensile strength and fluid pressure (pore pressure).

T = Tensile strength = 5 MPa

P_f = Pore pressure = 15 MPa

Calculated Here:

Leakage factor = $P_f / (\sigma_N + |T|)$ = .31455

Values Calculated and Displayed in Tendency Plot Window:

Leakage factor = $P_f / (\sigma_N + |T|)$ = .314

Does the color beneath the normal to the fault (white square) match the legend color for this leakage factor?
Yes

6.2.4 Success Criteria

All the procedures should be performed and their results verified for success.
Verified.

6.3 Test 3: Slip Tendency Plot with Fluid Pressure and Vertical Variations of σ_v, σ_{h1}, and σ_{h2}.

6.3.1 Objectives

Verify the accuracy of Slip Tendency Plot at depth with fluid pressure and vertical variations of σ_v, σ_{h1}, and σ_{h2}.

6.3.2 Test Input

None.

6.3.3 Test Procedure

Protocol:

a. Open the Stress Input display and under Stress Field Type, select Vertical Variation.
b. Under σ_v, select ρgh, enter values for ρ and g.
c. Under Fluid Pressure, select Water Table.
d. Under depth to water table, enter a value.
e. Under σ_{h1}, select σ_{h1}/σ_v, and enter a number between 0 and 5.
f. Under σ_{h2}, select σ_{h2}/σ_v, and enter a number between 0 and 5.
g. Under Ground elevation, enter a value.
h. Under Tendency Plot, enter a Z value that is between the ground elevation and the water table elevation.
i. Manually calculate depth of Slip Tendency Plot from the ground; σ_v, σ_{h1}, and σ_{h2} at this depth; fluid pressure at this depth.

Inputs:

ρ = <u>2.65 g/cm^3</u>
g = <u>9.81 m/s^2</u>
σ_{h1}/σ_v = .6, σ_{h1} direction = <u>0°</u>
σ_{h2}/σ_v = .5, σ_{h2} direction = <u>90°</u>
Tendency Plot elevation = <u>200 m</u>
Ground elevation = <u>300 m</u>
Depth to water table = <u>150 m</u>

Calculation:

Depth of Slip Tendency Plot from the ground = Ground Elevation − Tendency Plot Elevation = 100 m

σ_v = 2.59965 MPa
σ_{h1} = 1.55979 MPa
σ_{h2} = 1.299825 MPa

Fluid pressure = 0 MPa

j. Verify accuracy of magnitudes and orientations of σ_v, σ_{h1}, and σ_{h2} on Slip Tendency legend.

σ_u = 2.59965 MPa
σ_v = 1.55979 MPa
σ_w = 1.299825 MPa

k. Under Tendency Plot, enter a Z value that is less than the ground elevation and has a depth greater than the depth to the water table.

l. Manually calculate depth of Slip Tendency Plot from the ground; σ_v, σ_{h1}, and σ_{h2} at this depth; fluid pressure, and σ_v', σ_{h1}', and σ_{h2}' at this depth.

Inputs:

ρ = 2.65 g/cm^3
g = 9.81 m/s^2
σ_{h1}/σ_v = .6
σ_{h2}/σ_v = .5
Tendency Plot elevation = -100 m
Ground elevation = 300 m
Depth to water table = 150 m

Calculation:

Depth of Slip Tendency Plot from the ground = Ground Elevation – Tendency Plot Elevation = 400 m

σ_v = 10.3986 MPa
σ_{h1} = 6.23916 MPa
σ_{h2} = 5.1993 MPa

Fluid pressure = 2.4525 MPa

σ_v' = 7.9461 MPa
σ_{h1}' = 3.78666 MPa
σ_{h2}' = 2.7468 MPa

m. Verify accuracy of magnitudes and orientations of σ_v', σ_{h1}', and σ_{h2}' on Slip Tendency legend.

σ_u' = 7.9461 MPa
σ_v' = 3.78666 MPa
σ_w' = 2.7468 MPa

Values are correct.

6.3.4 Success Criteria

All the procedures should be performed and their results verified for success.
Verified.

6.4 Test 4: Test the Loading of a Three-Dimensional Varying Stress Field and Calculations

6.4.1 Objectives

Verify loading of three-dimensional stress field.

6.4.2 Test Input

3dStressField_Vertical.txt
3dStressField_Vertical.flt

6.4.3 Test Procedure

a. Open the Stress display, the Plot display, and the Viewer display.
b. Under Stress Field Type, select 3D.
c. Load file "3dStressField_Vertical.txt."
d. Select "Show Tensors."
e. Select "Move Plot Location To Selected Tensor" and select a tensor.
f. Verify that the magnitudes of the selected tensor match the magnitudes displayed in the Tendency Plot window:

Selected Tensor in Stress Tool

σ_u = 100 MPa
σ_v = 50 MPa
σ_w = 5 MPa

Tensor in Tendency Plot

σ_u = 100 MPa
σ_v = 50 MPa
σ_w = 5 MPa

g. In the Viewer, load the file "3dStressField_Vertical.flt".
h. Under the Document's Options dialog, click Select All and Plot Selected to plot the poles to the loaded 3D fault file.
i. Verify that color representing the fault triangle nearest the selected tensor matches the color displayed in the Tendency Plot window for that fault's orientation.

6.4.4 Success Criteria

All the procedures should be performed and their results verified for success.
Verified.

6.5 Test 5: Rose Diagram

6.5.1 Objectives

Verify the display and calculations of the Rose Diagram of Map Files.

6.5.2 Test Input

2pt5DegreeIncrements_Length1_snake.lin
2pt5DegreeIncrements_Length1_snake_mirror.lin

6.5.3 Test Procedure

a. Open the Viewer and load the file 2pt5DegreeIncrements_Length1_snake.lin as a 2D map file. 2pt5DegreeIncrements_Length1_snake.lin contains 3 fault traces. Each fault trace is composed of segments which have a length of one. Each segment on a fault trace has a difference in orientation of 2.5° from the previous segment. The first fault trace is composed of 4 segments while the remaining two are composed of 5 segments.
b. On the toolbar of the Document window click on the Rose button to load the Rose Diagram.
c. Open the options of the Rose Diagram by clicking on the Options button.
d. Using the Bin Size buttons, alternate between 5°, 10° or 20°. Browse the Rose Diagram by clicking the Browse Data button and save text outputs of the rose diagram for each bin size.
e. On the toolbar of the Document window, click on the Options button to view the Document's Options.
f. Under the Document's Options dialog, browse the Segments of the Map Faults. Save a text file.
g. Open the 3 text files from the Rose Diagram (created in Step d) in Excel or in a text editor.
h. Verify the strike range of the segments.
i. Verify that the cumulative orientations contained in each of the Rose Diagram output files (created in Step d) are correct.
j. Compare the calculated value (slip tendency) in the Rose Diagram output files (created in Step d) with that of output produced from the Document's Browse Data function (created in Step f).
k. Repeat the above steps on the file 2pt5DegreeIncrements_Length1_snake_mirror.lin

6.5.4 Success Criteria

All the procedures should be performed and their results verified for success.
Verified.

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: *532*	*2. Software Title and Version:* 3DStress 3.1	*3. Project No:* 20.06002.01.062
4. Affected Software Module(s), Description of Problem(s): **Fix problems with the display of the failure envelopes in the Mohr Circle window:** **(A) Failure envelopes are poorly drawn near the x-intercept (shear stress = 0). Not enough segments are drawn to represent the curving envelope and users can see individual line segments.** **(B) Hybrid and shear failure mode are incorrectly colored when the failure envelope is set to be colored by the failure mode.**		
7. Change Requested by: **David A Ferrill and Nathan Franklin** **Date: 8 / 30 / 2004**	*8. Change Authorized by (Software Developer):* **Nathan Franklin** **Date: 8 / 30 / 2004**	
9. Description of Change(s) or Problem Resolution: **Please see attachment, "Description of Change(s) or Problem Resolution"**		
10. Priority: **N.A.**	*11. Approximate Level of Effort and Scheduled Completion Date:* **4 days, 8/30/04**	
12. Implemented by: **Nathan Franklin**	*Date:* **9/3/04**	
13. Description of Acceptance Tests: **Please see attachment, "Description of Acceptance Tests"**		
14. Tested by: [signature]	**Date:** 8 Aug 2005	

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

Here is the description of the changes or problem resolution.

(A) The drawing of the failure envelope was modified. Now, additional line segments are drawn as the slope of the envelope increases. The major files which contain these changes are mohrGL.cpp, and mohrGL.h in the mohr subdirectory.

(B) The source code was changed so that now the segment of the envelope which crosses the x-axis (shear stress = 0) is colored with the shear failure mode color. The major files which contain these changes are mohrFailureEnvelope.cpp, mohrFailureEnvelope.h, mohrGL.cpp, and mohrGL.h in the mohr subdirectory.

Description of Acceptance Tests

A. Ability to represent the failure envelope near the x-intercept.

Summary: Verify that failure envelopes are drawn with enough detail near the x-intercept (shear stress = 0).

Protocol:
1. Open the Mohr display.
2. Open the Mohr Options dialog and activate the Failure Envelope tab.
3. Open "tuffaceousenv.xml" and select the failure envelope.
4. Click and hold the color button (located to the right of the Name input box) for that failure envelope.
5. Select "Color by failure mode".
6. Zoom and inspect the envelope near the x-intercept.
7. Verify that the envelope is drawn with enough detail in this region.

SOLARIS: Pass APvy

B. Ability to color the failure envelope by the failure mode.

Summary: Verify that user has the ability to color the failure envelope by the failure mode.

Protocol:
1. Open the Mohr display.
2. Open the Mohr Options dialog and activate the Failure Envelope tab.
3. Open "tuffaceousenv.xml" and select the failure envelope.
4. Click and hold the color button (located to the right of the Name input box) for that failure envelope.
5. Select "Color by failure mode"
6. Verify that the envelope is now colored correctly by its failure mode. The portion of the envelope where normal stress is positive should be colored by the shear failure mode color, while the portion of the envelope where normal stress is negative should be colored by the hybrid failure mode color. When the shear stress is equal to zero, the segment of the failure envelope should be colored by the color representing tensile failure mode.

SOLARIS: Pass APvy

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: *533*	***2. Software Title and Version:*** 3DStress 3.1	***3. Project No:*** 20.06002.01.062

4. Affected Software Module(s), Description of Problem(s):

Fix problems with the Vertical Variation dialog:
(A) When Stress Mode is in Vertical Variation, the application uses a large amount of CPU's resources.
(B) Currently, users can input a maximum depth that is less than the minimum depth when setting the depth range of the Vertical Variation dialog's plot.

7. Change Requested by: **Nathan Franklin** **Date: 9 / 2 / 2004**	***8. Change Authorized by (Software Developer):*** **Nathan Franklin** **Date: 9 / 2 / 2004**

9. Description of Change(s) or Problem Resolution:

Please see attachment, "Description of Change(s) or Problem Resolution"

10. Priority: **N.A.**	***11. Approximate Level of Effort and Scheduled Completion Date:*** **NA**
12. Implemented by: **Nathan Franklin**	***Date:*** **6/2/05**

13. Description of Acceptance Tests:

Please see attachment, "Description of Acceptance Tests"

14. Tested by: [signature]	**Date:** 8 Aug 2005

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

Here is the description of the changes or problem resolution.

(A) The plot in the Vertical Variation dialog was constantly repainting itself. A series of lines causing continual paint events was removed from variationPlot.cpp.

(B) The source code was changed to not allow the user to set a maximum depth less than the minimum depth for the range of the Vertical Variation plot. variationPlotOptions.cpp is the file which contains these changes and is located in the stress subdirectory.

Description of Acceptance Tests

Here is the description of the acceptance tests.

A. Use of the computer's resources by the plot in the Vertical Variation dialog.

Summary: Verify that plot in the Vertical Variation dialog is not using significant resources.

Protocol:
1. Open the Stress tool and select the Vertical Variation mode.
2. Open a terminal and run the unix program "top" to see the cpu usage of 3DStress.
3. Verify that the percentage of CPU usage of the software remains below 5% when not performing any other actions in 3DStress.

SOLARIS:. Pass [illegible]

B. Maintaining proper minimum and maximum depth values for the range of the Vertical Variation plot.

Summary: Verify that user cannot input a negative depth value or a minimum depth value that is less than the maximum depth.

Protocol:
1. Open the Stress tool and select the Vertical Variation mode.
2. Open the Variation Plot Options dialog by clicking on the Options button below the plot.
3. Attempt to set the minimum depth or maximum depth to a negative value.
4. Attempt to set the values of the minimum and maximum values such that the minimum depth exceeds the maximum depth.
5. Verify that the user can not input a negative depth value and that software requires the minimum depth to be less than the maximum depth.

SOLARIS:. Pass [illegible]

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: *534*	***2. Software Title and Version:*** 3DStress 3.1	***3. Project No:*** 20.06002.01.062

4. Affected Software Module(s), Description of Problem(s):

(A) ASCII output files are not uniquely identified by date, time, name, and version as stated in TOP–018, Revision 9 DEVELOPMENT AND CONTROL OF SCIENTIFIC SOFTWARE.

(B) 3DStress does not warn users when attempting to write over previously saved data.

7. Change Requested by: **Nathan Franklin and Bob Brient** **Date: 8 / 21 / 2003**	***8. Change Authorized by (Software Developer):*** **Nathan Franklin** **Date: 8 / 21 / 2003**

9. Description of Change(s) or Problem Resolution:

Please see attachment, "Description of Change(s) or Problem Resolution"

10. Priority: **N.A.**	***11. Approximate Level of Effort and Scheduled Completion Date:*** **N.A.**
12. Implemented by: **Nathan Franklin**	***Date:*** **6/30/05**

13. Description of Acceptance Tests:

Please see attachment, "Description of Acceptance Tests"

14. Tested by: Ale. Morris	**Date:** 8 Aug 2005

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

(A) Software was changed so that all ASCII ouput from 3DStress includes the name and version of the software as well as the date and the time. The major files which contain these changes are roseGL.cpp, plotDataUI.cpp, tdsDocument.cpp, optionsMohrCircle.cpp, optionsMohrFailureEnvelope.cpp, and singleTensorUI.cpp.

(B) When saving output files, users are now warned if they are attempting to save over a previously saved file. They are given the option of overwriting the file or selecting a file name. The major files that contain these changes are imageSaveDialog.cpp, browseDataUI.cpp, optionsMohrCircle.cpp, optionsMohrFailureEnvelope.cpp, and singleTensorUI.cpp.

Description of Acceptance Tests

Here is the description of the acceptance tests.

A. Verify that the Rose diagram output file is uniquely identified by date, time, software name, and software version and verify that user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Viewer.
2. Load a fault file containing 2D map traces of faults (*.lin).
3. In the Document window, load the Rose Diagram.
4. Under the Rose Diagram's options menu, select Browse Data to view and then save the loaded data.
5. Open and verify that the output file contains the date, time, name, and version information.
6. Repeat previous steps and attempt to save over the previously saved file. Verify that the user is properly warned.

SOLARIS: Pass ABM

B. Verify that the Tendency Plot output file is uniquely identified by date, time, software name, and software version and verify that user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Tendency Plot.
2. Open the Options dialog and select Browse Data to view and save the loaded data.
3. Open and verify that the output file contains the date, time, name, and version information.
4. Repeat previous steps and attempt to save over the previously saved file. Verify that the user is properly warned.

SOLARIS: Pass ABM

C. Verify that the 3D and 2D fault output files are uniquely identified by date, time, software name, and software version and verify that user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Viewer display.
2. Open the Document menu.
3. Load the "simonds_nobox.lin" fault file which contains 2D map traces of faults.
4. Load the "bmflt.flt" fault file which contains 3D fault surfaces.
5. Open the Options dialog and select Browse Data to view and save the loaded "Map Faults" (as either the segments or at the center point of segments).
6. Open the Options dialog and select Browse Data to view and save the loaded "3D Faults" (as either the triangles or at the center point of triangles).
7. Open and verify that the output files contain the date, time, name, and version information.
8. Repeat previous steps and attempt to save over the previously saved file. Verify that the user

is properly warned.

SOLARIS: Pass ABM

D. Verify that the Mohr circle output file is uniquely identified by date, time, software name, and software version and verify that the user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Mohr display.
2. Open the Mohr Options dialog and activate the Mohr Circle tab.
4. Save the default circle to an output file.
5. Open and verify that the output file contains the date, time, name, and version information.
6. Repeat previous steps and attempt to save over the previously saved file. Verify that the user is properly warned.

SOLARIS: Pass ABM

E. Verify that the Mohr failure envelope output file is uniquely identified by date, time, software name, and software version and verify that user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Mohr display.
2. Open the Mohr Options dialog and activate the Failure Envelopes tab.
3. Save the default envelope to an output file.
4. Open and verify that the output file contains the date, time, name, and version information.
5. Repeat previous steps and attempt to save over the previously saved file. Verify that the user is properly warned.

SOLARIS: Pass ABM

F. Verify that the single tensor output file is uniquely identified by date, time, software name, and software version and verify that user is properly warned when attempting to write over a previously saved file.

Protocol:
1. Open the Stress tool and activate the Single tab.
2. Save the stress tensor to an output file.
4. Open and verify that the output file contains the date, time, name, and version information.
5. Repeat previous steps and attempt to save over the previously saved file. Verify that the user is properly warned.

SOLARIS: Pass ABM

G. When saving an output image of the Tendency Plot, verify that user is properly warned when attempting to write over a previously saved file.

Protocol:

1. Open the Tendency Plot.
2. Click on the "Save image of plot" button (which has a camera icon).

3. Save an image of the plot.
4. Repeat previous steps and attempt to save over the previously saved image file. Verify that the user is properly warned.

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: *535*	***2. Software Title and Version:*** **3DStress 3.1**	***3. Project No:*** **20.06002.01.062**
4. Affected Software Module(s), Description of Problem(s): ***In Map View Mode, the Viewer displays loaded files incorrectly (upside down) and the translation control behaves incorrectly.***		
7. Change Requested by: **Nathan Franklin** **Date: 2 / 7 / 2005**	***8. Change Authorized by (Software Developer):*** **Nathan Franklin** **Date: 2 / 7 / 2005**	
9. Description of Change(s) or Problem Resolution: **Please see attachment, "Description of Change(s) or Problem Resolution"**		
10. Priority: **N.A.**	***11. Approximate Level of Effort and Scheduled Completion Date:*** **N.A.**	
12. Implemented by: **Nathan Franklin**	***Date:*** **6/10/05**	
13. Description of Acceptance Tests: **Please see attachment, "Description of Acceptance Tests"**		
14. Tested by: [illegible]	**Date:** 8 Aug 2005	

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

The openGL function (glOrtho) for setting up the view's projection in map mode contained incorrect input variables. These were corrected and the changes are contained in view.cpp in the Viewer subdirectory.

Description of Acceptance Tests

Here is the description of the acceptance test.

A. Verify that users can set the viewing settings to have a "map view" of the data.

Summary: Verify that in the 3D Fault Viewer window, the user can create a map view of the data by clicking on the map view button or by selecting Map View in the Viewer Options menu under the View Reset Mode section.

Protocol:
1. Open the Viewer and load the file simonds_nobox.lin.
2. On the toolbar of the document's Viewer window, click on the Map View Mode button. Verify that the image resets to a map view of the data. Click on the Map View Mode button again to undo this selection. Verify that the map returns to its original view.
3. Open the Viewer Options menu for this document by clicking on the Options button on the Viewer window. Under the View Reset Mode section of the Viewer Options menu, select Map View and verify that the view of the data returns to a map view when the Reset View button is clicked.
4. Status: Pass/Fail:
   SOLARIS: Pass ARM

B. Verify that data is correctly displayed and there is correct user control in the Viewer while in the Map View Mode.

Summary: Verify that while in Map View Mode, the Viewer correctly displays the data and that the user can translate and zoom correctly.

Protocol:
1. Open the Viewer and load the file north_example.lin.
2. On the toolbar of the document's Viewer window, click on the Map View Mode button. Verify that the image resets to a map view of the data and that the north arrow points to the top of the viewer.
3. Use the mouse to translate (left mouse button pressed) and to zoom in and out (middle mouse button pressed). Verify that the view of the map translates and zooms correctly.
4. Status: Pass/Fail:
   SOLARIS: Pass ARM

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: *536*	***2. Software Title and Version:*** 3DStress 3.1	***3. Project No:*** 20.06002.01.062
4. Affected Software Module(s), Description of Problem(s): ***Verify that proper colors (for slip tendency, dilation tendency, and leakage factor) are displayed on the rose diagram and add additional bin sizes (20° and 5°) to the rose diagram***		
7. Change Requested by: **Nathan Franklin** **Date: 4 / 28 / 2004**	***8. Change Authorized by (Software Developer):*** **Nathan Franklin** **Date: 4 / 28 / 2004**	
9. Description of Change(s) or Problem Resolution: **Please see attachment, "Description of Change(s) or Problem Resolution"**		
10. Priority: **N.A.**	***11. Approximate Level of Effort and Scheduled Completion Date:*** **NA**	
12. Implemented by: **Nathan Franklin**	***Date:*** **7/6/2005**	
13. Description of Acceptance Tests: **Please see attachment, "Description of Acceptance Tests"**		
14. Tested by: Alan M[signature]	**Date:** 8 Aug 2005	

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

The correct colors are now displayed for the calculated values on the Rose Diagram and in the map view for 2D line segments. An orientation perpendicular to the actual orientation of the fault traces was used in calculating the slip tendency, leakage factor and dilation tendency. Software was changed to allow the users to display the orientation data in 5°, 10° or 20° bins in the Rose Diagram. The major files which contain these changes are roseGL.cpp and plotDataUI.cpp.

Description of Acceptance Tests

A. Verify the ability for the users to display orientation data in 5°, 10° or 20° bins in the Rose Diagram.

Summary: Verify that the user can view strike values of loaded 2D fault traces in 5°, 10° or 20° bins in the Rose Diagram and that the help pages describe this feature to the users.
Protocol:
1. Open the Viewer and load the file simonds_nobox.lin as a 2D map file.
2. On the toolbar of the Document window, click on the Rose button to load the Rose Diagram.
3. Open the options of the Rose Diagram by clicking on the Options button.
4. Using the Bin Size buttons, alternate between 5°, 10° or 20° verify that the view of the rose diagram changes accordingly.
5. Using the Bin Size buttons, alternate between 5°, 10° or 20° and browse the data of the Rose Diagram by using the Browse Data button to verify that the text output of the rose diagram changes accordingly.
6. Click on the Help button on the Rose Diagram and verify that that the help pages describe the 5°, 10° or 20° bins sizes to the users.
7. Status: Pass/Fail:

SOLARIS: Pass

B. Verify the results of the Rose Diagram for the 5°, 10° and 20° orientation bins.

Summary: Verify that the results of the Rose Diagram for the 5°, 10° or 20° bins by comparing them to a simple loaded map file and the text output of the 3DStress.

Protocol:
1. Open the Viewer and load the file 0_to_360_length1.lin as a 2D map file.
0_to_360_length1.lin contains a set of separate lines segments with an orientation at every degree from 0° to 360°. Each segment has a length of one. There are two identical segments of the 361 segments, because orientation of 360 and 0 are the same.
2. On the toolbar of the Document window click on the Rose button to load the Rose Diagram.
3. Open the options of the Rose Diagram by clicking on the Options button.
4. Using the Bin Size buttons, alternate between 5°, 10° or 20°. Browse the Rose Diagram by clicking the Browse Data button and save text outputs of the rose diagram for each bin size.
5. On the toolbar of the Document window, click on the Options button to view the Document's Options.
6. Under the Document's Options dialog, browse the Segments the Map Files. Save a text file.
7. Open the 3 text files from the Rose Diagram (created in step 4) in Excel or in a text editor.
8. Verify the strike range of the 361 segments
9. Verify that the cumulative orientations contained in each of the Rose Diagram output files (created in step 4) are correct.
10. Compare the calculated value (slip tendency) in the Rose Diagram output files (created in step 4) with that of output produced from the Document's Browse Data function (created in step 6).
11. Status: Pass/Fail:

SOLARIS: Pass Alim

SOFTWARE CHANGE REPORT (SCR)

1. SCR No.: 601	2. Software Title and Version: 3dstress 3.1	3. Project No: 20.06002.01.062
4. Affected Software Module(s), Description of Problem(s): **Description of leakage factor in the help pages and when inputting values is unclear.**		
7. Change Requested by: Nathan Franklin Date: 7 / 22 / 2005	8. Change Authorized by (*Software Developer*): Nathan Franklin Date: 7 / 22 / 2005	
9. Description of Change(s) or Problem Resolution: Please see attachment, "Description of Change(s) or Problem Resolution"		
10. Priority: N.A.	11. Approximate Level of Effort and Scheduled Completion Date: N.A.	
12. Implemented by: Nathan Franklin	Date: 7/25/05	
13. Description of Acceptance Tests: Please see attachment, "Description of Acceptance Tests"		
14. Tested by: [signature]	Date: 29 July 2005	

CNWRA Form TOP-5 (05/2000)

Description of Change(s) or Problem Resolution

The description of leakage factor has been changed in the software (colorLegend.cpp) and in the help pages (overview.html). On the tendency plot, the description of leakage factor is "$P_f/(\sigma_n + |T|)$" and the help pages were updated to the following:
Leakage factor *is a quantitative estimate of the propensity for a fault or fracture to dilate; it is a measure of the ability of pore fluid pressure to overcome the far-field, or tectonic, stresses, and the tensile strength of a fault or fracture. Fluid pressure and fault or fracture tensile strength must be known or inferred. Leakage factor is computed as a function of pore fluid pressure (P_f), σ_n (the far-field, or tectonic stress, not the effective stress), and tensile strength (T) by the equation below:*
Leakage factor $= P_f/(\sigma_n + |T|)$

Description of Acceptance Tests

Here is the description of the acceptance test.

A. Verify the description of Leakage Factor

Summary: Verify that an updated description of Leakage Factor exists in the Tendency Plot window and in the overview section of the help pages.

Protocol:

1. Open the Options and select Leakage Factor to be computed.
2. Open the Tendency Plot window.
3. Verify that the formula for Leakage Factor is "$P_f/(\sigma_n + |T|)$"
4. Load the 3DStress help manual and navigate to the Overview help page.
3. Verify that the information about Leakage Factor has been updated to the following: ***Leakage factor*** *is a quantitative estimate of the propensity for a fault or fracture to dilate; it is a measure of the ability of pore fluid pressure to overcome the far-field, or tectonic, stresses, and the tensile strength of a fault or fracture. Fluid pressure and fault or fracture tensile strength must be known or inferred. Leakage factor is computed as a function of pore fluid pressure (P_f), σ_n (the far-field, or tectonic stress, not the effective stress), and tensile strength (T) by the equation below:*
   Leakage factor = $P_f/(\sigma_n + |T|)$

4. Status: Pass/Fail:
   SOLARIS: PASS ✓